Geotechnical Engineering Investigation

Langley Air Force Base F-22 Beddown Program Hampton, Virginia

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TABLE OF CONTENTS

LIST OF TABLES

Tables

LIST OF FIGURES

Figures

LIST OF APPENDICES

Appendix

EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation prepared in support of Burns & McDonnell's design efforts for the proposed construction of the FY-02 F-22 Beddown Program Project at the Langley Air Force Base in Hampton, Virginia. This program includes the design and construction of a Low Observable restoration and Composite Repair Facility, an Airfield Lighting Vault, a Vertical Tank Storage Building, a Base Operations Facility, AMU Hangars, and Fire Protection Tanks. These facilities are to be constructed at various locations along the south side of the airfield. EEE Consulting, Inc. of Richmond, Virginia performed this investigation under contract to Burns & McDonnell of Kansas City, Missouri.

This investigation was performed to evaluate the geotechnical engineering conditions for the proposed structures. The scope of this investigation did not include the evaluation of environmental concerns related to soil or groundwater contamination.

The findings of our investigation are based on the results of a field reconnaissance, twenty-six geotechnical exploratory borings, field and laboratory tests, review of regional geologic and soils maps, and our engineering analysis of the collected data.

The soils encountered during the subsurface exploration of the site generally consisted of firm to stiff sandy and silty clay (CL) and very loose to medium dense silty sand (SM). These materials generally extended to depths of 5.0 to 10.0 feet. These materials were underlain by bluish gray; very loose to medium dense silty, very fine-grained sand (SM) which extended to the maximum depth explored in this investigation of 65 feet. Varying amounts of shell fragments and small whole shells were encountered in this silty, fine-grained sand layer.

The three primary considerations for foundation design at this site are the high water table, the layers of very loose sand encountered near the elevation of the water table (depth of 5 to 10 feet) and the proximity of existing masonry structures to the proposed facilities. The water table encountered in the exploratory borings ranged in depth from about 5 to 9 feet below the existing ground surface. This water table (which is typical for this area of Virginia) will limit the depths of excavations that can be made without the installation of temporary dewatering. A layer of very loose sand was encountered in almost all the borings at or near the groundwater elevation. These very loose sands extended from about 5 to 10 feet below the ground surface. This layer will be subject to settlement from loadings from the proposed structures. In addition, this layer will provide little support for foundation systems. Finally, the proximity of existing masonry structures to the proposed facilities may impact the type of foundation system selected or may affect the foundation system installation method. The nearby masonry structures may be subject to distress due to vibrations from the installation of some foundation systems (driven piles). In addition, there is an older brick structure located adjacent to the proposed fire protection tanks. Settlements induces by these tanks may cause settlement and cracking in this older structure.

Therefore, design recommendations for several foundation systems, including both deep and shallow foundations, are presented. The selection of the most appropriate system for each of the structures should be based on the structural requirements of the individual buildings. In general, the deep

foundation systems will be subject to limited settlements and will induce limited settlements to adjacent structures. Shallow foundations will be subject to some settlement but the cost of this type of foundation is significantly less than the deep foundation system.

We recommend that the AMU Hangar, the LO/CRF and the Base Operations Facility be supported on deep foundations. The Vertical Tank Storage and the Light Vault may be supported on spread footings provided the criteria for maximum foundation depth, presented in Section 4.2.2can be met. If this criterion can not be met then deep foundations will be necessary. The fire protection tanks may be supported on a ring wall for the shell and the bottom can be supported on grade. However, settlements on the order of 5 inches should be anticipated. These tanks need to be spaced away from existing structures and preloaded to induce the settlement prior to construction of the pump house.

Overall, the soils encountered during the subsurface investigation will be suitable for reuse as structural fill beneath foundations and pavements. Some petroleum contamination was encountered in the vicinity of the Base Operations Facility and the LO/CRF area. It is our understanding that this apparent release has been previously investigated and is well documented. Any contaminated soils or groundwater encountered should be properly handled and disposed.

The apparent groundwater table was encountered during the drilling at depths ranging from 5 to 9 feet below the existing ground surface. Because rotary wash drilling techniques were used to maintain the integrity of the boreholes, an accurate reading of the groundwater elevation at the completion of drilling was not obtained. However, based on our review of the laboratory test results, the standard penetration testing and our visual observations of the collected soil samples, we estimate that the stabilized groundwater surface is at a depth of about 7 feet below the existing ground surface

The soils at the site exhibit soaked California Bearing Ratio (CBR) values ranging from 3.8 to 12.8 when compacted to a minimum of 98 percent of the standard Proctor maximum dry density (moisture contents approximately 1 to 2 percent dry of the optimum moisture content). These CBR values represent actual test results and should be appropriately reduced or recalculated based on applicable pavement design method.

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation prepared in support of Burns & McDonnell's design efforts for the proposed construction of the FY-02 F-22 Beddown Program Project at the Langley Air Force Base in Hampton, Virginia. This program includes the design and construction of AMU Hangars, a Low Observable Restoration and Composite Repair Facility, an Airfield Lighting Vault, a Vertical Tank Storage Building, a Base Operations Facility, and Fire Protection Tanks. These facilities are to be constructed at various locations along the south side of the airfield. Figure 1 presents the general facility layout and regional topography. EEE Consulting, Inc. of Richmond, Virginia performed this investigation under contract to Burns & McDonnell of Kansas City, Missouri.

This investigation was performed to evaluate the geotechnical engineering conditions for the proposed structures. The scope of this investigation did not include the evaluation of environmental concerns related to soil or groundwater contamination.

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1.1 SITE DESCRIPTION

The proposed F-22 Beddown Facilities are located along the south side of the Langley airfield. Figure 1 (overall Site Plan and Area Topography) shows the approximate locations of the proposed facilities. The Low Observable Restoration and Composite Repair Facility (LO/CRF) and airfield lighting vault are the only structures that will be located in an area that has not been previously developed. The LO/CRF is located in a grass area immediately north of the Base Fire Station and the lighting vault will be located immediately north of the LO/CRF. The grass area is located between the Flightline Road to the south and west, the tarmac to the north, and an unused runway to the east. The new Base Fire Station is located south of Flightline Road. The Base Operations Facility will be located immediately west of the airfield tower in the location of the old fire station. The old fire station was previously demolished and the concrete slabs are all that remain. The AMU hangars will be located where hangars 754, 755, and 756 are currently located. The fire protection tanks will be located in a parking lot immediately adjacent to Building 782. The proposed locations of these structures are shown on the attached site plans (Figures 2, 3, and 4)

The airfield is located at an elevation of 11 feet mean sea level (msl). There is very little relief across the sites of the proposed construction. The ground surface elevations at the individual exploratory boring locations ranged from 4.18 to 8.55 feet msl. Elevations of the individual borings are presented on the boring logs presented in Appendix A.

1.2 PROPOSED CONSTRUCTION

The proposed project consists of the construction of several new structures, including: AMU Hangars, a Low Observable Restoration and Composite Repair Facility, an Airfield Lighting Vault, a Vertical Tank Storage Building, a Base operations Facility, and a Fire Protection Tank(s).

The project includes a new six-bay Squadron Operations/AMU Hangar with adjoining maintenance shops, an administration area and a squadron support section for the new F-22 multi-role fighter. The six-bay aircraft maintenance hangar will be an open structure that is framed with steel roof trusses. The two-story squadron operations and AMU areas will be framed with conventional hot-rolled shapes for beam and column members. Interior and perimeter column loads for the squadron operations building are anticipated to be 175 kips and 80 kips for dead plus live loads, respectively. Column loads for the AMU Hangar are anticipated to be 150 kips for dead plus live loads with maximum loads of 250 kips and minimum loads of –150 kips when including wind loadings. Perimeter wall loadings are anticipated to be 1,300 psf. The maximum anticipated lateral loading will be on the order of 30 kips.

The Base Operations Facility will be a one-story structure framed with conventional hot-rolled shapes for beams and columns. It is anticipated that maximum loads will be 60 kips and minimum loads of –15 kips including wind loading. The perimeter wall loads are anticipated to be 1,300 psf. The maximum anticipated lateral loading will be on the order of 8 kips.

The Low Observable Restoration and Composite Repair Facility will include a three-bay area for composite materials maintenance and repair/wash areas for the new F-22 multi-role fighter. The aircraft maintenance wash bays will be framed with steel roof trusses. Maximum and minimum vertical loading in the shop area are 35 and –15 kips, respectively. In the hangar areas the maximum and minimum vertical loadings are anticipated to be 45 and –45 kips, respectively. The maximum anticipated lateral loading in this area will be on the order of 15 kips. The perimeter wall loadings are anticipated to be 1,300 psf.

Two water tanks used for fire protection will be located adjacent to the pumphouse. A third tank will also be located in this area that will be used for foam. The tanks are anticipated to be 22 feet in diameter and 24 feet high with a capacity of 67,000 gallons. It is anticipated that the exterior structure of the tanks will be supported on a ring wall and that the tanks will have a flexible bottom.

1.3 OBJECTIVES AND SCOPE OF WORK

The objectives of this study were to evaluate subsurface conditions in the vicinity of the proposed structures and to develop geotechnical engineering recommendations to guide design and construction of foundations and adjacent pavements. Burns & McDonnell requested that the geotechnical investigation include twenty-six exploratory borings. The anticipated boring depths ranged from 5 feet below the existing ground surface (BGS) to 65 feet bgs. The maximum depth explored during this investigation was 65 feet. To accomplish these objectives, the following tasks were performed:

1. Twenty-six exploratory borings (17 for analysis of structures and 9 for analysis of pavements) were drilled to depths ranging from 5 feet (for pavement evaluations) to 65 feet to explore the subsurface conditions and to provide soil samples for laboratory testing.

2. A geotechnical engineer classified collected soil samples in the field.

3. Laboratory tests were performed to measure pertinent soil properties including soil strength and classification.

4. Engineering analysis of the field and laboratory data was made to develop recommendations for foundation design and construction.

It should be noted that specific pavement designs were not requested as part of this investigation. Laboratory testing was performed on near-surface soil samples to evaluate the California Bearing Ratios (CBR) of these materials. These values can be used along with traffic information to develop appropriate pavement designs. Table 4 presents a summary of the CBR test results; the detailed laboratory CBR results are presented in Appendix B.

The scope of this investigation included evaluation of the geotechnical engineering conditions for the proposed structures. This scope did not include the evaluation of environmental concerns related to soil or groundwater contamination.

1.4 REVIEW OF PREVIOUS REPORTS ADDRESSING THE OLD BASE FIRE STATION

Following the issuance of the Draft Geotechnical Engineering Investigation for the F-22 Beddown Project in mid-March 2001, five reports that addressed the old Base Fire Station were made available for review. These reports addressed observed distress in the old Base Fire Station, which was located where the Base Operations Facility is to be constructed. This structure was apparently demolished sometime in the recent past. All that remains of the previous structure are the interior floor slabs. References to these previous reports are presented below. In addition, generalized findings of the reports pertinent to this geotechnical investigation are presented in Section 3.4 of this report.

"Engineering Study of Building 375, Langley AFB, Virginia, Contract DACA65-86-D-0001", Prepared by MacIlroy and Parris, Architects, P.C. and St. Clair, Callaway & Frye, Engineers, dated June 12, 1986.

"Structural Investigation, Fire Station – Building 375", prepared for the Department of the Air Force, Langley Air Force Base, prepared by The CEGG Partnership, Architects – Engineers – Surveyors, dated July 1989.

"Advanced Subsurface Investigation Report for the Base Fire Station, Building 375 at Langley Air Force Base, Virginia", prepared for Waller Todd & Sadler, prepared by Metcalf & Eddy, dated April 18, 1990.

"Structural Investigation Report for Base Fire Station, Building 375 at Langley Air Force Base, Virginia", prepared for Waller Todd & Sadler, prepared by Metcalf & Eddy, dated June 28, 1990.

"Final Report on Structural Analysis of Base Fire Station, Langley Air Force Base, Virginia", prepared for Waller Todd & Sadler, prepared by Metcalf & Eddy, dated October 23, 1990.

A brief summary of the pertinent geotechnical findings of these reports as they relate to the design and construction of the proposed Base Operations Facility are presented in Section 3.4 of this report.

2.0 METHODS OF INVESTIGATION

Subsurface soil conditions at the site were evaluated by drilling twenty-six exploratory borings with a truck-mounted drill rig using rotary wash drilling techniques. Seventeen of the borings were drilled to depths ranging from 25 to 65 feet and nine were drilled to a depth of five feet. The locations of the borings are shown on Figures 2, 3, and 4. The borings were drilled with a BK-41C truck-mounted drill rig using rotary wash drilling techniques. Detailed descriptions of the soils encountered are presented on the attached boring logs in Appendix A.

During the geotechnical investigation, subsurface soils encountered in the borings, were sampled and used to evaluate foundation conditions for structures. Samples were obtained continuously to a depth of 10 feet, and at approximately 5-foot intervals, thereafter. The soils were sampled by driving a 2-inch diameter split barrel sampler into the soil with a 140-pound hammer free falling 30 inches using standard penetration test (SPT) procedures. The SPT borings were completed in general accordance with guidelines established in ASTM D-1586. Driving resistances for the split-barrel sampler are recorded on the attached boring logs (Appendix A). In addition, two relatively undisturbed samples of silty sand encountered in the borings were sampled with a thin-walled tube sampler (Shelby tube). Representative portions of the split spoon sample and Shelby tube samples were sealed and packaged in the field and delivered to a geotechnical engineering laboratory in Richmond, Virginia for classification and strength testing.

The laboratory testing program was directed primarily towards classification properties of the soils encountered in the borings. Prior to transport to the laboratory for testing, a geotechnical engineer visually classified the samples. Bulk samples of near surface soils were obtained from Borings LO-5, LO-6, BO-1, BO-1A, BO-4, BO-5, BO-6, AMU-7, and AMU-8. Laboratory testing of eight of these bulk samples consisted of standard Proctor and California Bearing Ratio (CBR) tests. The results of these tests were used to evaluate compaction properties of the soil and to provide soil strength data for the pavement design. Natural Moisture Content, Percentage Passing the No. 200 Sieve, and Atterberg limits tests were performed on selected jar samples obtained from borings within the building footprints for purposes of classification of the soil. In addition, a triaxial shear test was performed on an undisturbed Shelby tube sample to aid in the evaluation of the strength of the subsurface soils for deep foundation design. The following tests were performed as part of the laboratory program:

- Natural Moisture Content Test (ASTM D-2216),
- Percentage finer than,the No. 200 sieve (ASTM D-1140),
- Atterberg limits test (ASTM D-4318),
- Triaxial shear test – CU (with pore pressure measurements) (ASTM D-2850)
- Standard Proctor compaction test (ASTM D-698), and
- California Bearing Ratio (CBR) test (ASTM D-1883).

The moisture content testing was performed on the near surface soils to assist with the evaluation of the depth to the water table and the suitability of excavated soils as structural fill. Moisture content determinations were also performed in several of the borings to the maximum depths explored. The purpose of this testing was evaluate how consistent these soils were with depth.

The results of the laboratory tests are presented in Appendix B.

3.0 SITE CONDITIONS

3.1 REGIONAL GEOLOGY AND MAPPED SOILS

The site is located within the Atlantic Coastal Plain physiographic province. The mapped surficial soils belong to the Lynnhaven Member (Figure 5). The Lynnhaven soils are described as pebbly and cobbly, fine to coarse gray sand grading upward into clayey silty fine sand and sandy silt. In the area of the Langley AFB, the total thickness of the Lynnhaven soils varies from about 5 to 15 feet. These surficial deposits are underlain by the soils of the Yorktown formation. The Yorktown formation is Miocene in age. The top of the Yorktown formation typically consists of a relatively thin layer of bluish gray to gray highly plastic clay. This layer typically acts as an aquaclude between the overlying soils and the underlying Yorktown soils. The underlying soils of the Yorktown formation typically consist of bluish gray to gray, fossiliferous, medium dense silty sands, and firm to very stiff sandy silts and silty clays. Shell beds are often abundant in this formation.

3.2 SUBSURFACE CONDITIONS

A total of twenty-six exploratory borings were drilled across the area of proposed development to investigate the subsurface conditions. Seven borings, in which SPT testing was conducted, and 2 shallow probes, from which bulk samples were obtained for CBR testing, were drilled in the AMU Hangar area. Two borings and five probes were drilled around the Base Operations Facility, four borings and two probes were drilled in the LO/CRF area, two borings were drilled for the vertical tank storage facility, one boring was drilled for the light vault and one boring was drilled for the Fire Protection Tanks. The locations of the borings and probes were selected by Burns & McDonnell in consultation with EEE Consulting. Field personnel from EEE located the borings in the field by taping and pacing from known landmarks. The locations of the proposed structures and the exploratory borings are shown on Figures 2, 3, and 4.

Many of the borings were located in areas of asphalt or concrete pavement. Prior to drilling, the pavement was cored to limit the disturbance to the surrounding pavement surface. Table 3 summarizes the surface conditions at each of the boring locations. In general, the concrete around the proposed Base Operations Facility was observed to have a thickness that ranged from 4.5 to 10.5 inches. In the AMU Hangar area four of the borings had surface materials that consisted of asphalt overlying concrete. In these areas the pavement section consisted of 2.25 to 3 inches of asphalt over 6 to 8.5 inches of concrete. Two of the borings encountered only asphalt. In this case, the asphalt thickness ranged from 3 to 4 inches.

The subsurface conditions encountered in the exploratory borings were relatively uniform across the entire study area. In the AMU Hangar area the near surface soils consisted of firm to stiff sandy and silty clay (CL) and very loose to medium dense silty sand (SM). These materials generally extended to depths of 5.5 to 8.0 feet. These surface soils were underlain by bluish gray, very loose to medium dense silty, very fine grained sand (SM) which extended to the maximum depth explored in this area of 65 feet. Varying amounts of shell fragments and small whole shells were encountered in this layer.

The near surface soils encountered in the area of the Base Operations Facility generally consisted of medium dense, clayey and silty sands (SC and SM) and stiff silty, clay (CL). These materials extended to depths of about 11 to 12.5 feet below the ground surface. A distinct petroleum odor was noted in samples from each of the borings at depths of about 4 to 8 feet. The near surface soils were underlain by bluish gray, loose silty, very fine grained sand (SM) which extended to the maximum depth explored in this area of 45 feet. Varying amounts of shell fragments and small whole shells were encountered in this layer.

Four borings were drilled in the LO/CRF area, two were drilled in the Vertical Tank Storage Area and one was drilled for the light vault. All three of these proposed facilities are in the same general area. The soils in this area generally consisted of very loose to medium dense, clayey and silty sand (SC/SM) which extended to depths of about 5 to 9 feet. In boring LO-2 the top four feet of soil consisted of stiff to very stiff, silty, clay fill soil. A petroleum odor was detected in a sample from a depth of 6 feet in LO-2. This depth generally coincided with the depth of the water table in the area. This material was underlain by very loose to loose silty sand (SM) that extended to the maximum depth explored in this area of 50 feet. Varying amounts of shell fragments and small whole shells were encountered in this lower layer.

One boring was advanced in the area of the proposed fire protection tanks. This boring generally encountered medium dense, silty sand (SM) that extended to a depth of about 4 feet. This material was underlain by very loose to loose silty sand (SM) that extended to the maximum depth explored in this area of 50 feet. Varying amounts of shell fragments and small whole shells were encountered in this lower layer.

3.3 GROUND WATER

Seventeen of the borings drilled as part of this investigation were advanced to a sufficient depth to encounter the ground water table. The apparent groundwater table was encountered during the drilling at depths ranging from 5 to 9 feet below the existing ground surface. Because rotary wash drilling techniques were used to maintain the integrity of the boreholes, an accurate reading of the groundwater elevation at the completion of drilling was not obtained. The depth to groundwater has been inferred from the results of the standard penetration tests and the moisture content determinations. Based on the review of laboratory soil moisture content data, the results of the standard penetration testing, and our visual observations of the collected soil samples, we estimate that the stabilized groundwater surface is at a depth of about 7 feet below the existing ground surface. However, in this area the groundwater is likely influenced by the tides resulting in daily groundwater elevation fluctuations of 1 to 2 feet. Therefore, for design purposes, a groundwater elevation of 5 feet below the existing ground surface should be assumed. The borings were backfilled with cement bentonite slurry immediately following the drilling operations. It should be noted that fluctuations in the ground-water level may also occur due to variations in rainfall, temperature and other factors not evident within the short duration of this subsurface investigation.

3.4 REVIEW OF PREVIOUS REPORTS FOR THE OLD BASE FIRE STATION

In March 2001, EEE was provided with five engineering reports that addressed observed distress in the old Base Fire Station. These reports presented results of extensive investigations, which included the drilling of exploratory borings, laboratory analysis of soil and groundwater samples and structural evaluations of the building.

In summary, the final report prepared by Metcalf & Eddy, dated October 23, 1990 concluded that failure of the soils underlying the building foundations was not the cause of the distress observed in the structure. The analyses lead to the general conclusion that the predominant cause of the damages and deformations was horizontal expansion of the concrete pavement adjacent to the north side of the building (this was apparently former Taxiway 7). It was concluded that the horizontal expansion of this former taxiway was thermally induced and was compounded by pavement joint deficiencies and insufficient maintenance of the existing expansion joints in the concrete. Metcalf & Eddy recommended that a repair program be immediately implemented to return the structure to a satisfactory condition, and that a rebuild program be initiated for implementation within the next five years.

The October 23, 1990 report also presented depth to groundwater data from eight borings/monitoring wells located in the immediate vicinity of the old Base Fire Station. The depths to groundwater reported ranged from 5.4 to 7.0 feet below the existing ground surface (which is consistent with the results presented in Section 3.3 of this investigation).

4.0 GEOTECHNICAL RECOMMENDATIONS

The following recommendations are based on a review of the attached boring logs and laboratory data, EEE's understanding of the proposed construction, and past experience with similar projects and subsurface conditions. Should the proposed development plans or structural conditions differ significantly from those on which our recommendations are based, EEE should be allowed the opportunity to review and evaluate the findings of this report so that the recommendations may be confirmed, extended, or modified as necessary. Should subsurface conditions be encountered during construction that are different from those encountered in this investigation, then those differences should be reported to EEE for review and evaluation.

The three primary considerations for foundation design at this site are the high water table, the layers of very loose sand encountered near the elevation of the water table (depth of 5 to 9 feet) and the proximity of existing masonry structures to the proposed facilities. The water table encountered in the exploratory borings ranged in depth from about 5 to 9 feet below the existing ground surface. This water table (which is typical for this area of Virginia) will limit the depths of excavations that can be made without the installation of temporary dewatering. A layer of very loose sand was encountered in almost all the borings at or near the groundwater elevation. These very loose sands extended from about 5 to 10 feet below the ground surface. This layer will be subject to settlement from loadings from the proposed structures. In addition, this layer will provide little support for foundation systems. Finally, the proximity of existing masonry structures to the proposed facilities may impact the type of foundation system selected or may affect the foundation system installation method. The nearby masonry structures may be subject to distress due to vibrations from the installation of some foundation systems (driven piles). In addition, there is an older brick structure located adjacent to the proposed fire protection tanks. Settlements induces by these tanks may cause settlement and cracking in this older structure.

Therefore, design recommendations for several foundation systems, including both deep and shallow foundations, are presented below. The selection of the most appropriate system for each of the structures should be based on the structural requirements of the individual structures. In general, the deep foundation systems will be subject to limited settlements and will induce limited settlements to adjacent structures. Shallow foundations will be subject to some settlement but the cost of this type of foundation is significantly less than the deep foundation system.

We recommend that the AMU Hangar, the LO/CRF, and the Base Operations Facility be supported on deep foundations. The Vertical Tank Storage and the Light Vault may be supported on spread footings provided the criteria for maximum foundation depth, presented in Section 4.2.2 can be met. If this criterion can not be met then deep foundations will be necessary. The fire protection tanks may be supported on a ring wall for the shell and the bottom can be supported on granular materials placed and compacted within the ringwall. However, settlements on the order of 5 inches should be anticipated. These tanks need to be spaced away from existing structures and preloaded to induce the settlement prior to construction of the pump house.

4.1 EARTHWORK

4.1.1 Site Grading

Due to the relatively flat topography of the area, it is likely that the site grading to establish building pads will be minimal. It is our understanding that the design plans for some of the structures have column bases located below the adjacent concrete slab floors. This may result in some excavations on the order of 4 to 6 feet in depth. Soils generated by these excavations will be suitable for re-use as structural fill provided these materials are not contaminated or otherwise environmentally unsuitable. Some petroleum contamination was encountered in the borings drilled in the LO/CRF and the Base Operations Facility areas. It is our understanding that separate environmental evaluations have been performed for this apparent release. Soils generated from excavations in these areas should be evaluated for contamination and, if contaminated, disposed of properly (environmental sampling and testing of soil and groundwater was outside the scope of this investigation).

Soils derived from on-site cutting or excavation operations (excluding topsoil) would be suitable as structural fill (except as noted above). However, due to the relatively high ground water table, cut soils may require drying prior to placement as structural fill. Details regarding the placement and compaction of structural fill are presented in Section 4.1.4 Structural Fill.

Site work should begin with the clearing of all vegetation and topsoil or the demolition and clearing of debris from existing structures, from those areas designated for construction of the new facilities. All vegetation, topsoil, and debris should be removed from the site. Holes resulting from the removal of existing foundation elements or other underground obstructions should be properly backfilled with compacted structural fill soil. Following stripping operations, areas at grade or designated to receive fill should be proofrolled with a partially-loaded dump truck or similar piece of rubber tired equipment to identify those areas requiring repair. Any area which ruts or pumps excessively in the opinion of the geotechnical engineer should be repaired in the field as directed by the geotechnical engineer prior to the beginning of fill operations. Based on our observation and SPT information, it does not appear that large quantities of undercut will be required except where saturated soils are encountered.

Other than organic topsoil, the need for undercutting is directly related to the moisture condition of natural soils at the time earthwork is initiated. The natural near-surface soils are moderately well drained but may become soft and difficult to compact during the typically wetter winter months of November through April or May. In addition, during these wetter months it is very difficult to dry soils that are above the optimum moisture content. To avoid delays during site grading operations, we recommend earthwork activities be scheduled after May and prior November, if possible, to facilitate site grading work.

4.1.2 Excavation Considerations

Based on our discussions with Burns & McDonnell it appears that some excavation work for column bases and pile caps (on the order of 4 to 6 feet) may be required for the proposed facilities. The

primary considerations for site excavations are the relatively high ground water level and the possibility of caving of the sides of the excavations. As excavations get closer to the groundwater table (approximately 5 feet below the existing ground surface) soil moisture content will increase dramatically and the consistency of the soils will become looser (softer). Excavations that extend below a depth of about 5 feet will likely encounter groundwater seeps and very soft excavation bases. During our subsurface investigation "running" sands were not encountered in the borings. In open cut situations some of these sands may exhibit a tendency to run. In addition, some of the near surface soil layers encountered may tend to slough when exposed in vertical cuts. Ultimately, the need for and design of temporary shoring and dewatering should be the sole responsibility of the contractor. All excavations should conform to applicable OSHA guidelines for safety considerations.

4.1.3 Ground-Water Control

Based on ground-water observations during the field investigation, ground-water control should not be a significant issue provided the excavations are limited to depths of 5 feet below the existing ground surface. The loose, saturated, fine grained sands extending from a depth of about 5 feet to 10 feet bgs can produce significant quantities of water and the exposed soils may tend to "run" when exposed in open cuts. The contractor should be prepared to install temporary shoring and dewatering for any excavations that may encounter the water table. The ultimate determination of the need for temporary shoring and its design should be the sole responsibility of the contractor. In addition, the design of temporary dewatering systems should be the responsibility of the contractor.

If temporary or permanent excavations are planned that extend below an elevation equivalent to 5 feet below the existing ground surface, then water proofing and/or sump pumps should be anticipated.

During the exploratory drilling apparently contaminated soils were encountered in some of the borings drilled for the LO/CRF and the Base Operations Facility. If groundwater is encountered in these areas during construction it may be contaminated and require special handling and disposal. It is our understanding that a number of environmental studies have been conducted in association with this contamination. We recommend that these studies be reviewed prior to construction. In addition, it would be prudent to require the testing of the groundwater prior to construction. During the field portion of this investigation a number of monitoring wells were noted in this area that would provide a means of obtaining groundwater samples.

4.1.4 Structural Fill

All saturated and/or organic laden topsoil materials and petroleum contaminated soils should be considered as unsuitable for reuse as structural fill and should be removed from the building area and disposed of properly. Overall, the soils encountered at the site will be suitable for reuse as structural fill beneath foundations and pavements. Prior to placement of the fill the natural soils should be scarified to a minimum depth of 6 inches. This scarification will provide adequate meshing of placed fill materials at the fill interface which will minimize the potential of shear failure. All fill material placed on the site should be compacted to at least 95 percent of the modified Proctor

maximum dry density (ASTM D 1557) except in the final 12-inches beneath pavements and floor slabs where this requirement should be increased to 98 percent of the modified Proctor maximum dry density. Fill material should be placed in thin lifts not to exceed 8 inches (loose measure) and compacted within 2 percent of the optimum moisture content. The project specifications should require testing of each lift of fill to confirm the required degree of compaction is achieved. A Nuclear Moisture Density Gauge (NMDG) will be suitable for compaction testing of on-site material if used as structural fill. Alternative methods of testing compaction (Sand Cone - ASTM D1556-90 or Drive Cylinder - ASTM D 2937-90) may be utilized periodically for verification of the accuracy of the NMDG test results during placement of structural fill. For earthwork volume considerations, a shrinkage factor of 10 to 15 percent is recommended when virgin soils are recompacted as engineered fill.

If off-site soils are used as structural fill, the materials best suited for this use are either a low plasticity clay (e.g., silty or sandy clay - CL) or relatively clean sands (SM, SC, SP, SW). Low plasticity clays should have plasticity indices and liquid limits less than about 25 and 45, respectively. Granular soils (sand) should have less than 40 to 50 percent passing the No. 200 sieve (percent fines). While soils can be used which have properties outside these limits, the higher the plasticity (plasticity index and liquid limit), and the more fines (percent passing the No. 200 sieve), the more moisture sensitive and the more difficult to compact. High plasticity clays and silts should not be used as structural fill.

4.1.5 Utility Installation

EEE recommends utility pipes be placed directly over at least 6 inches of open-graded crushed stone, such as No. 57 stone or clean sand to provide a leveling cushion and a stable base for the pipe. If very soft, unstable soil conditions are encountered at the invert elevation, the trenches should be overexcavated approximately12 inches and replaced with clean sands or open graded stone. Determination of the need to undercut unsuitable soils should be made during construction by the geotechnical engineer or experienced senior soil technician.

All backfill placed over the pipe should be compacted to at least 95 percent of the modified Proctor maximum dry density except in the final foot beneath pavements or building subgrades where the requirement should be increased to 98 percent of the modified Proctor maximum dry density. If the soil cannot be compacted beneath and adjacent to the pipe, stone should be used for backfill. The initial lift of soil backfill over the pipe should consist of material not containing large pieces of rock or weathered rock to serve as a cushion over the pipe for subsequent fill placement and compaction. Additionally, in-place density tests should be performed to confirm backfill compaction requirements are being met. Most soils removed from the excavation may be utilized as backfill providing they can be suitably compacted. Shallow excavations should hold a neat vertical line for temporary trench cuts; however, all excavations should be in accordance with applicable OSHA regulations for safety to workmen.

4.1.6 Seismic Potential

The proposed site lies within a band which extends up the east coast of the Mid-Atlantic states rated as Zone 1, as determined by the U.S. Coast and Geodetic Survey. This rating system ranges from 0 (no damage) to 3 (major damage) and estimates the seismic risk in the United States. Zone 1 is defined as being only a slight risk of minor damage due to a major earthquake. The probable frequency of occurrences of major earthquakes was not considered in assigning ratings to the various zones; however, the proposed site is not in a high-intensity-earthquake-prone area of the United States.

4.2 FOUNDATION DESIGN AND ANALYSES

The primary geotechnical considerations for foundation design are the layer of very loose to loose sands that are present from a depth of about 5 to 10 feet beneath the ground surface, the high water table, and the presence of old masonry buildings (near some of the structures) that may be damaged by construction related vibrations. In order to accommodate these design constraints, EEE is presenting multiple foundation recommendation alternatives. These alternatives represent both shallow and deep foundation systems. These recommendations will give the project designers the necessary information to select the appropriate foundation system for each structure.

Our review of design information for structures in the immediate vicinity of the proposed F-22 Beddown Facilities indicates that both shallow spread footings and timber piles have historically been used. It is our understanding that the old Fire Station, which is the location of the proposed Base Operations Facility, was supported on shallow spread footings. Although the old Fire Station experienced significant distress over its lifetime, the general conclusion developed by Metcalf & Eddy was that the distress was related to thermal expansion of an old adjacent taxiway and not on foundation failure. However, Metcalf & Eddy stated that it was likely that any future structures in this area should be supported on a deep foundation system. The new Fire Station, which is located approximately 600 feet south of the proposed LO/CRF and about 1,000 southeast of the old Fire Station, is founded on timber pile foundations.

We have received conflicting information regarding the foundations supporting the existing hangars located in the area of the proposed AMU Facility. We were initially informed that these structures were supported on shallow spread footings. However, we were recently informed that these buildings might actually be supported on timber piles. To date, we have not reviewed any documentation that could confirm either foundation type. We recommend that the foundation system supporting these structures be determined. The foundation type will affect the cost to demolish the structures that are to be removed. In addition, the type of foundation will affect the susceptibility of the remaining structures in the immediate area to possible vibration and settlement induced damage.

4.2.1 Driven Pile Foundations

Our review of design information for structures in the vicinity of the proposed F-22 Beddown

Facility indicates that timber piles have historically been the deep foundation system of choice. However, it is our experience that pre-stressed concrete piles are being used more frequently and are becoming more affordable for these types of facilities. In addition, some of the design lateral loads may push the limits of the lateral capacity of timber piles.

Because both timber and pre-stressed concrete piles are a form of displacement pile they may be prone to premature refusal. Therefore, we recommend that piles to be used at this facility be relatively short – 25 feet. Pre-drilling of the piles to a depth of 15 feet will reduce driving induced vibrations without significantly affecting the pile load carrying capacity. The diameter of the pre-drill hole should be no greater than 2/3 of the diameter of the pile (for 12-inch square concrete piles the maximum pre-drill hole is 8-inches).

The Soil Survey for the area indicates that the mapped soils in the vicinity of the site possess a moderate to high corrosion potential. Due to the mapping of high corrosion potential soils at the site EEE recommends that the piles be adequately corrosion protected prior to installation. Corrosion protection for concrete piles may include such measures as the use of Type II cement, air entrainment, or corrosion inhibitor additives. It is our conclusion that cathodic protection is not required. In addition, we recommend that timber piles be treated to resist decay with bitumen or an equivalent compound.

The subsurface investigation revealed a very loose to loose layer of fine grained, silty sand that generally extended from 5 to 10 feet below the existing ground surface. This soft layer appears to be directly related to the presence of the water table in this zone. Below a depth of 10 feet the soils generally became loose to medium dense, silty sands. From a depth of about 10 feet beneath the existing ground surface combination friction and end bearing piles will develop the load carrying capacity.

The allowable load carrying capacity of the two pile types recommended are presented in Table 1. These calculations have been made assuming both end bearing and skin friction contribute to the pile capacity for compression. Ideally, piles should be spaced with a minimum of three (3) pile diameters (center to center) between adjacent piles. At this spacing the full capacity of the pile should be available. If piles are spaced closer than 3 pile diameters there is a greater likelihood that the driving operations will cause shifting of the adjacent, previously installed piles. In no case should piles be spaced closer than 2 pile diameters.

Table 1
Axial and Lateral Pile Capacities
F-22 Beddown Program
Langley Air Force Base

Pile Type	Pile Length (ft)	Axial Compression Capacity (FS=3)	Axial Compression Capacity (FS=2)	Axial Tension Capacity (FS=3)	Lateral Load Capacity (0.5 inch deflection) Brom's Method
Timber Pile (Minimum tip diameter 8-inches)	25	9 tons	13 tons	5 tons	0.4 tons single pile free head condition
					0.7 tons single pile fixed head condition
Pre-stressed Concrete Pile (12x12 inch square)	25	17 tons	25 tons	7.5 tons	1.5 tons single pile free head condition
					3.0 tons single pile fixed head condition

With these loading conditions we estimate the settlement of the individual piles as less than 0.25 inches.

It is possible to increase the axial pile capacities presented in Table1 by driving the piles deeper. However, if the piles are driven deeper to achieve greater axial capacities a larger pile hammer will likely be required which would increase the vibrations induced by the pile driving. These increased vibrations may adversely impact adjacent structures. Soil conditions, pile hammer, and pile type directly influence the pile driveability. A practical limit for timber pile length is about 60 feet with an upper limit for axial pile capacity is about 50 tons.

It has been our experience that the fine sand soils that underlie the site tend to set-up over short periods of time. Thus, retapping of the piles if required may be difficult.

The allowable lateral load carrying capacity of the individual piles has been calculated for both the fixed and free head conditions and is presented in Table 1. In the free head condition, the assumptions of no load eccentricity and an allowable lateral deflection of 0.5 inches at the ground surface were used.

It is our understanding that Burns & McDonnell intend to employ the computer program LPILE Plus to evaluate the lateral load carrying capacities of the piles for the AMU structures. Table 2 presents recommended soil input values for this area of the site.

Table 2
Lateral Capacity Determination – LPILE Plus Model Input
Pile Foundations – AMU Area

Depth Range (ft)	Soil Type	N_{avg}	Dry Unit Weight (pcf)	Wet Unit Weight (pcf)	Phi angle (degrees)	Cohesion (psf)	k (pci)	E_{50}
Representative Borings AMU-3, 4, 9								
0-4	CL/SC	12	95	110	0	1,000	250	0.006
4-11	SM/SP	<4	75	110	30	0	20	0
>11	SP	8	87	115	34	0	60	0
Representative Borings AMU-1, 2, 5, 6								
0-5	CL/SC	9	95	110	0	1,000	250	0.006
5-15	SM/SP	<4	75	10	30	0	20	0
>15	SP	8	87	115	34	0	60	0

Pile foundations should be driven with a hammer having adequate rated energy to overcome the driving resistance during installation. Once a hammer is selected, a wave equation analysis should be performed to evaluate the hammer properties. We recommend that at least one pile load test be performed prior to installation of all the piles for any given structure. The installation of the test pile should be performed with the equipment proposed for production installation. The installation of the test pile and as well as the pile load test should be performed under the observation of a geotechnical engineer. We recommend that load testing be performed no sooner than 10 days following the pile driving to allow for dissipation of excess pore pressures from the soil around the pile.

It is our understanding that Burns & McDonnell intend to require pile load testing at each of the building locations. By requiring field load testing, a factor of safety of 2 may be applied to the measured ultimate pile capacity to arrive at the allowable pile capacity (UBC 1997). This methodology for determining the allowable pile capacity is acceptable and will provide a more accurate measurement of the true allowable pile capacity. For initial design purposes, the axial capacities presented in Table 2 using the Factor of Safety of 2 may be used.

In areas where existing structures are located near the proposed construction we recommend vibration monitoring of these existing structures during the pile driving. The vibrations produced by the driving operations may cause cracking in some of these older masonry structures. At a minimum, a crack survey of the adjacent structures should be performed before commencement of the pile driving. The purpose of this monitoring should be to assist in the assessment of the effects of the pile driving on the adjacent structures. It is our opinion, that a structural engineer should be consulted regarding the type and frequency of vibration monitoring. We anticipate that predrilling for the piles should reduce the possibility of producing vibrations that could cause damage to the structures.

To the extent possible, the installation of the piles should be a continuous operation without termination of driving until the point of acceptable resistance or embedment is achieved. The silty sands of the Yorktown formation tend to set following pile driving operations, thus making re-

driving difficult. Pile driving within a given pile group, should begin at the center of the group and progress outward to reduce hard driving of interior piles due to soil densification (this is especially important for prestressed concrete piles). If piles experience heave or rise of more than ¼ inch after driving, they should be re-driven to seat the tip of the pile in the bearing stratum.

It is recommended that all piles be driven in the presence of a geotechnical engineer experienced in pile driving. If premature refusal of the piles is encountered, we recommend that a pile driving analyzer be used to evaluate hammer efficiency and energy prior to approving early cut off. During the pile installation, the following quality control observations should be performed by the geotechnical engineer:

- Observe the pile installation equipment and report non-conformance to the specifications
- Continuously observe the pile installation
- Have knowledge of the soil conditions at the site and the required penetration of each pile
- Record and report movement of previously installed adjacent piles
- Observe piles prior to installation for any obvious defects
- Count and record the blows per foot during the driving
- Recommend halting of driving operations when unanticipated difficulties or conditions are encountered

4.2.2 Shallow Foundations

Should the designers determine that deep foundations are not required for the Vertical Tank Storage or the Lighting Vault the following shallow foundation recommendations should be employed. It should be noted that mixing deep and shallow foundations for the same structure may result unsatisfactory differential settlement in the structure.

Conventional continuous and isolated spread footings bearing (on undisturbed native soils or) on compacted fill may be used at the designers discretion. All footings should be founded at least 18 inches below the nearest adjacent finished grade. In addition, footing excavations should not be extended to depths greater than 2.5 feet below the existing ground surface so as to not encounter the water table or the loose (soft) soils associated with the water table. If deeper excavations are required, shallow foundations should not be considered an appropriate foundation alternative. Footings located adjacent to other footings or utility trenches should have their bearing surfaces situated below an imaginary 1.5 horizontal to 1 vertical plane projected upward from the bottom of the adjacent footing or utility trench.

At the above depths, the footings may be designed for an allowable bearing pressure of 1,500 pounds per square foot due to dead loads, 1,875 pounds per square foot due to dead plus live loads and 2,250 pounds per square foot for all loads including wind or seismic. The allowable load capacity calculated for dead loads includes a factor of safety of 3.0. The allowable bearing pressures are net values; therefore, the weight of the footing can be neglected for design purposes. All footings should have a minimum width of 14 inches, and all continuous footings should be tied together with reinforcing steel. Footings should not have a minimum horizontal dimension less than 12 inches. Maximum anticipated settlements of shallow foundations are 1.25 inch with a maximum differential

settlement of approximately 0.6 inches.

All continuous footings should be designed with adequate top and bottom reinforcement to provide structural continuity and to permit spanning of local irregularities. Any visible cracks in the bottoms of the footing excavations should be closed by wetting prior to construction of the foundations. To assure that footings are founded on appropriate material, we recommend that a geotechnical engineer observe the footing excavations prior to placing steel or concrete.

Lateral load resistance may be developed in friction between the footing bottom and the supporting subgrade. A friction coefficient of 0.30 is considered applicable. As an alternative, a passive resistance equal to an equivalent fluid weighing 300 pounds per cubic foot acting against the foundations may be used. If the foundations are poured neat against the soil, friction and passive resistance may be used in combination.

4.2.3 Fire Protection Tank Ring Wall

We recommend that the exterior shell of the fire protection tanks be supported on a shallow strip footing bearing on compacted fill. Prior to construction two feet of structural fill soil should be placed in the tank area to provide a smooth uniform base for footing and tank support. The footing should be founded at least 18 inches below the lowest adjacent finished grade. In addition, the footing should be founded no greater than 3 feet below the existing ground surface. If deeper excavations are required, a shallow foundation may not be an appropriate foundation alternative. If the footing is located adjacent to other footings or utility trenches its bearing surface should be located below an imaginary 1.5 horizontal to 1 vertical plane projected upward from the bottom of the adjacent footing or utility trench.

At the above depths, the strip footing may be designed for an allowable bearing pressure of 1,500 pounds per square foot due to dead loads, 1,875 pounds per square foot due to dead plus live loads and 2,250 pounds per square foot for all loads including wind or seismic. The allowable load capacity calculated for dead loads includes a factor of safety of 3.0. The allowable bearing pressures are net values; therefore, the weight of the footing can be neglected for design purposes. The strip footing should have a minimum width of 14 inches and should be tied together with reinforcing steel.

The interior of the ring wall should be backfilled with compacted granular structural fill to provide uniform support for the bottom of the tank.

All continuous footings should be designed with adequate top and bottom reinforcement to provide structural continuity and to permit spanning of local irregularities. Any visible cracks in the bottoms of the footing excavations should be closed by wetting prior to construction of the foundations. To assure that footings are founded on appropriate material, we recommend that a geotechnical engineer observe the footing excavations prior to placing steel or concrete.

Lateral load resistance may be developed in friction between the footing bottom and the supporting subgrade. A friction coefficient of 0.30 is considered applicable. As an alternative, a passive resistance equal to an equivalent fluid weighing 300 pounds per cubic foot acting against the

foundations may be used. If the foundations are poured neat against the soil, friction and passive resistance may be used in combination.

The fire protection tanks will have flexible bottoms with the exterior shell supported on a ring wall (strip footing). Total settlement induced by the loaded tank will be on the order of 5 inches. Consolidation testing was not performed on the fine-grained sands encountered beneath the site. However, a consolidated undrained (CU) triaxial shear test was performed on a sample of these materials obtained from the AMU area. EEE reviewed the consolidation data obtained from the triaxial test and performed a rough calculation of the time rate of settlement. Based on these calculations it is our opinion that 90 percent of the total settlement should be realized approximately six to eight weeks following the filling of the water tanks.

In order to confirm the magnitude and rate of settlement, it is still EEE's recommendation that survey-monitoring points be established around the perimeter of the tank ring walls (minimum of 4 points evenly spaced around each ring wall) prior to the initial filling of the tanks. The tanks should then be filled with water and allowed to settle. During this time period surveys of the benchmarks on the ringwall should be performed at least weekly to measure the settlement. A graph of settlement vs. time should be generated as an aid in evaluating when the primary settlement of the tanks is complete. These points should be monitored at least weekly.

In order to minimize damage to existing structures in the area and damage to the proposed pump house we recommend that the tanks be located a minimum of 40 feet from the existing brick building. In addition, the tanks should be constructed prior to construction of the pump house or connection of permanent piping to the tanks.

4.2.4 Retaining Walls for Pit Excavations

In the case of retaining wall design for pits, EEE recommends the use of an at rest earth pressure (K_o) equal to 0.60. For the soil conditions present at the site, we recommend an active earth pressure (K_a) equal to 0.40. Active earth pressures should only be used in cases where the retaining walls are considered unrestrained. In the case of pits within structures, the retaining walls should be considered restrained.

If the structural engineer determines that there are surcharge loads on the walls, the walls should be designed to resist an additional uniform pressure equivalent to one-half or one-third of the maximum anticipated surcharge load applied to the surface behind restrained or unrestrained walls, respectively.

The above pressures assume that sufficient drainage will be provided behind the walls to prevent the build-up of hydrostatic pressures from surface and subsurface water infiltration. In cases where there is the possibility of the retaining wall extending below the water table or where perched water may accumulate behind the retaining wall, hydrostatic pressures should be added to the design soil pressures.

Walls constructed above the seasonal high water table may be designed with adequate drainage to avoid superimposing a hydrostatic load. Adequate drainage may be provided by an underdrain system consisting of a four-inch rigid perforated pipe bedded in 3/4-inch clean, open-graded rock. The entire rock/pipe unit should be wrapped in an approved non-woven, polyester geotextile. The rock and fabric placed behind the wall should be at least one foot in width and should extend to within one foot of finished grade. The upper one-foot of backfill should consist of on-site, compacted, impervious soils. Flexible, perforated pipe is not acceptable pipe for use in the underdrain system. The underdrain pipe should be connected to a system of closed pipes that daylight from behind the wall. As an alternative to the underdrain system a series of weep-holes constructed at the bottom of the wall may be used. The construction of weep-holes through the wall will eliminate the need for the underdrain pipe behind the wall.

4.2.5 Interior Floor Slabs-On-Grade

We recommend that interior floor slabs be supported on a minimum of 6 inches of granular fill soil. The slabs may be designed for an assumed subgrade modulus of 90 pci in cut areas. This subgrade modulus may also be used in fill areas provided the upper 12 inches of the fill soil is compacted to a minimum of 95 percent of the modified Proctor maximum dry density. Prior to final construction of the slab, the subgrade surface should be proof-rolled to provide a smooth, firm surface for slab support. The slabs should be appropriately reinforced according to structural requirements; concentrated loads may require additional reinforcing.

In areas where floor wetness would be undesirable, 4 inches of free draining gravel should be placed beneath the floor slab to serve as a capillary barrier between the subgrade soil and the slab. In order to minimize vapor transmission, an impermeable membrane should be placed over the gravel.

We also recommend that the specifications for slab-on-grade floors require that moisture emission tests be performed on the slab prior to the installation of any flooring. No flooring should be installed until acceptable moisture emission levels are recorded for the type of flooring to be used.

4.2.6 Exterior Slabs-On-Grade

Exterior slabs-on-grade (pavement areas) should be supported by a minimum of 6 inches of compacted granular backfill. The slabs may be designed for an assumed subgrade modulus of 90 pci in cut areas. This subgrade modulus may also be used in fill areas provided the upper 12 inches of the subgrade is compacted to a minimum of 95 percent of the modified Proctor maximum dry density. Prior to final construction of the slab, the subgrade surface should be proof-rolled to provide a smooth, firm surface for slab support. Any areas that exhibit pumping or rutting during proofrolling should be repaired by undercutting the area and backfilling with either washed stone or properly compacted soil.

4.3 PAVEMENT DESIGN PARAMETERS

EEE has not been provided specific traffic loading information for this project. However eight samples of the near surface soils were obtained for California Bearing Ratio Testing (CBR). The

results of the CBR testing are discussed below with some general pavement design recommendations and presented in summary form on Table 4.

Six of the CBR tests produced values in the range of 4.2 to 6.4. Two of the tests produced CBR values of 10.4 and 11.0. During the bulk sampling of the soils for the testing, it was observed that some of the samples contained small pieces of gravel which were likely mixed into the soil matrix during the original construction operations. It is EEE's opinion that these small gravel pieces affected the CBR values in the two samples with the higher CBR values. For design purposes, EEE recommends that the lower CBR values be used. These values represent actual test results on existing materials at specific locations and should be appropriately reduced or recalculated based on applicable pavement design method.

Our subsurface investigation did not reveal the presence of previous subgrade stabilization beneath the existing pavements.

Pavement performance is directly related to subgrade support characteristics; therefore, the need for subgrade preparation immediately prior to base course placement is reemphasized as a necessary operation to provide a significant pavement service life.

Additionally, based on our experience with other projects in the area, we caution against operating heavy construction equipment on a partial pavement section. Numerous pavement failures and reduced pavement life have been observed at other facilities due to significant construction traffic operating on a reduced pavement section in which the final asphalt wearing course had not been placed. The omission of the final wearing course reduces the structural number of the pavement section such that the pavement section does not have suitable strength for supporting heavy loads. If the contractor chooses to delay placement of the final wearing course of asphalt until after completion of the majority of construction, we recommend that an increased pavement section be utilized to provide adequate support for the construction traffic.

TABLE 3
SUMMARY OF BORING LOCATION SURFACE CONDITIONS
F-22 BEDDOWN PROGRAM

Boring Location	Boring Number	Surface Conditions	Asphalt Thickness	Concrete Thickness
AMU Hangar	AMU-1	grass	***	***
AMU Hangar	AMU-2	grass	***	***
AMU Hangar	AMU-3	grass	***	***
AMU Hangar	AMU-4	asphalt	3 inches	6.5 inches
AMU Hangar	AMU-5	asphalt	1.25 inches	7 inches
AMU Hangar	AMU-6	asphalt	1.5 inches	6 inches
AMU Hangar	AMU-7	asphalt	2.25 inches	8.5 inches
AMU Hangar	AMU-8	asphalt	4 inches	none
AMU Hangar	AMU-9	asphalt	3 inches	none
LO/CRF	LO-1	grass	***	***
LO/CRF	LO-2	grass	***	***
LO/CRF	LO-3	grass	***	***
LO/CRF	LO-4	grass	***	***
LO/CRF	LO-5	grass	***	***
LO/CRF	LO-6	grass	***	***
Base Operations	BO-1	concrete	none	10.5 inches
Base Operations	BO-1A	concrete	none	10.0 inches
Base Operations	BO-2	concrete	none	7 inches
Base Operations	BO-3	concrete	none	4.5 inches
Base Operations	BO-4	asphalt	3.5	none
Base Operations	BO-5	grass	***	***
Base Operations	BO-6	grass	***	***
Vertical Tank Storage	VT-1	grass	***	***
Vertical Tank Storage	VT-2	grass	***	***
Light Vault	LV-1	grass	***	***
Fire Protection Tanks	PO-1	asphalt	3 inches	none

TABLE 4
SUMMARY OF CALIFORNIA BEARING RATIO TESTS
F-22 BEDDOWN PROGRAM

Boring No.	Sample Depth (ft)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	California Bearing Ratio (CBR)	
				0.1 inch penetration	0.2 inch penetration
LO-5	1-5	116	14	5.5	5.2
LO-6	1-5	117	12.5	5.5	6.5
BO-1	1-5	113.9	15	10.4	9.2
BO-1A	1-5	114	16	5.9	4.9
BO-5	1-5	108.5	18	5.0	4.4
BO-6	1-5	115	13.5	6.4	5.7
AMU-7	1-5	118.5	11.5	11.0	12.8
AMU-8	1-5	119	13.4	4.2	3.8

APPENDIX A

BORING LOGS

Soil Strength

Relative Density

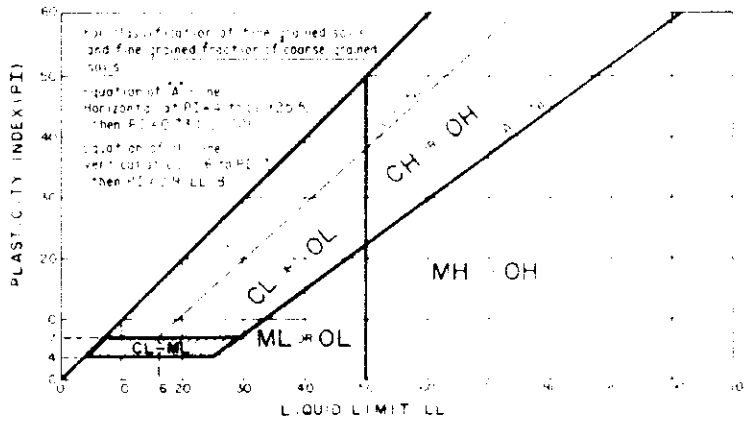
Coarse Grained Soil, SAND

N-Value	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
>50	Very Dense

Consistency

Fine Grained Soil, SILT or CLAY

N-Value	Relative Density
0-1	Very Soft
2-4	Soft
5-8	Medium Stiff
9-15	Stiff
16-29	Very Stiff
>29	Hard



Moisture Content

Dry	No apparent moisture, dusty.
Damp	Apparent moisture, below the Plastic Limit
Moist	Significant moisture, at or above the Plastic Limit (can be rolled into a 1/8" thread)
Wet	Appears saturated, free water in voids and pores.

Further Descriptors

Mottled	Irregularly marked with patches of different colors, variegated
Micaceous	Contains the mineral mica.
Relict Rock Structure	Distinct pattern of mineralization from parent rock.

3e EEE Consulting, Inc.
Environmental, Engineering and Educational Solutions

Key to Soil Classification
(Based on Unified Soil Classification System)

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 4.18 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	1:45				
DATE	1/17/01				
CASING DEPTH					

BORING NUMBER: AMU-1

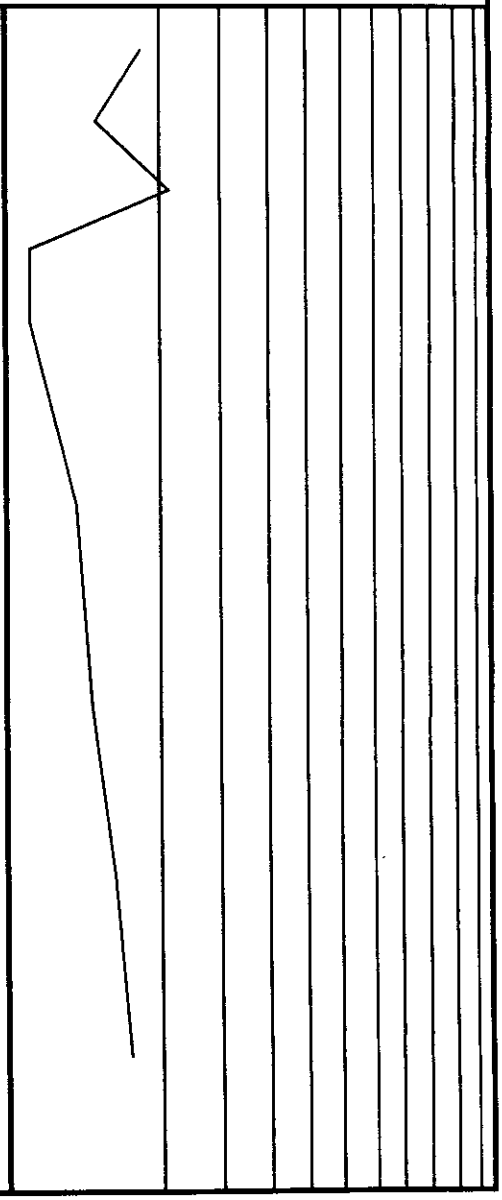
DRILLING START	DRILLING FINISH
TIME 1:30	TIME 2:10
DATE 1/17/01	DATE 1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			CLAY(CL), sandy, silty medium stuff to stiff with wood fragments, gray (fill)	9			
			CLAY (CL), sandy, medium to stiff, gray	5			
5				11			
			SAND(SC), v. fine-grained, clayey, very loose to loose, gray, few rounded pebbles	2			
				2	35		
10			Percent finer than No. 200 = 21.8%				
			SAND(SM), v. fine-grained, silty, very loose to loose, bluish gray, few shell fragments	4			
15			Percent finer than No. 200 = 15.1%				
				5	35		
20							
				7			
25			few shell graments and small intact shells				
				8			
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 4.18 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0			
TIME	1:45			
DATE	1/17/01			
CASING DEPTH				

BORING NUMBER AMU-1

DRILLING	START	FINISH
TIME	1:30	2:10
DATE	1/17/01	1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
35			(continued) SAND(SM), v. fine-grained, silty, very loose to loose, bluish gray, few shell fragments	12				
			Bottom of Boring @ 35'					
40								
45								
50								
55								
60								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION: AMU Building

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.21

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	7.0				
TIME	11:30				
DATE	1/17/01				
CASING DEPTH					

BORING NUMBER AMU-2

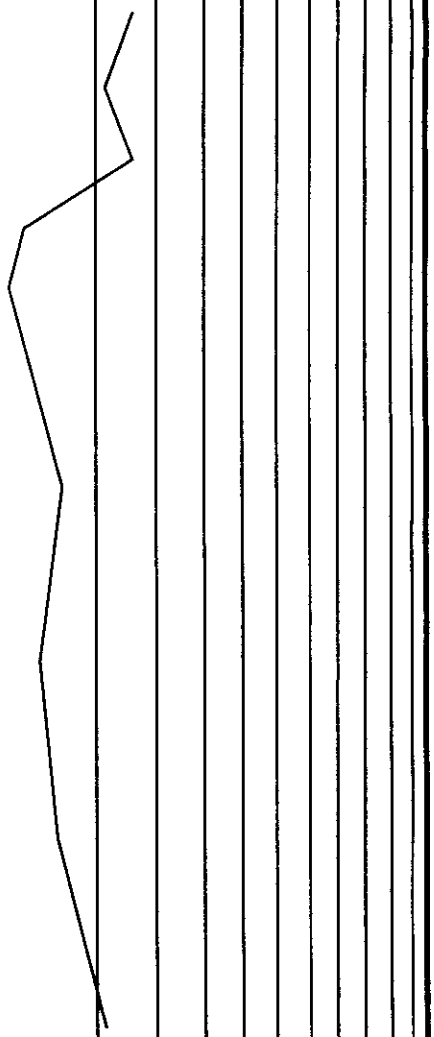
DRILLING	
START	FINISH
TIME 11:15	TIME 12:20
DATE 1/17/01	DATE 1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			SAND(SC), v. fine-grained, clayey, slightly silty, medium dense, mottled gray and brown	17	9		
				11	23		
5			SAND(SC), very fine grained, clayey, medium dense, mottled yellow brown and gray	17	20	47	29
			Percent finer than No. 200 = 32.7%	5	33		
10			SAND(SM), very fine-grained, slightly clayey, very loose to medium dense, bluish gray	4	34		
15			Percent finer than No. 200 = 16.8%	8	35		
20				7	37		
25			trace shells in sample @ 25'	8	33		
30				11	35		

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.21

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	7.0				
TIME	11:30				
DATE	1/17/01				
CASING DEPTH					

BORING NUMBER AMU-2

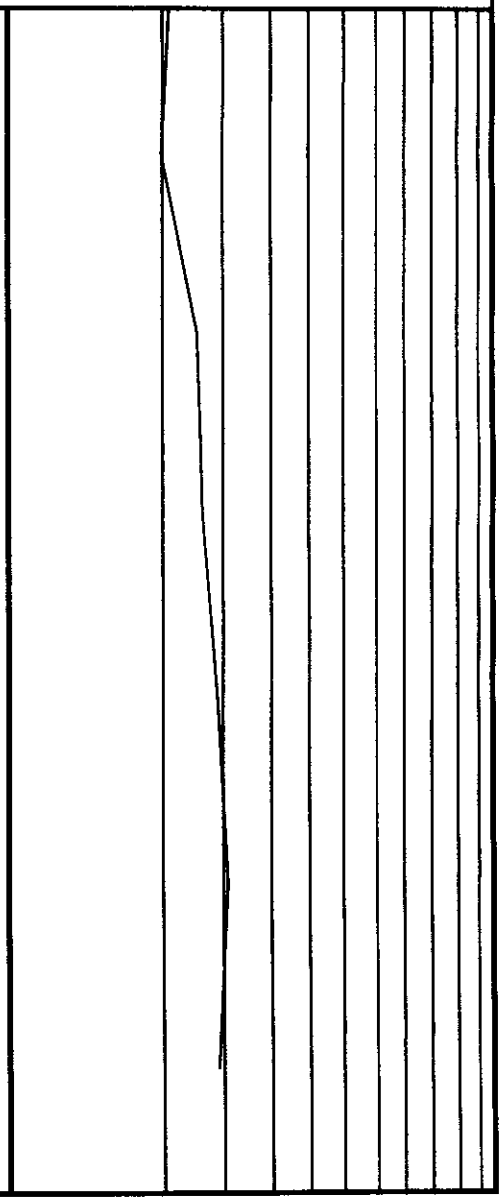
DRILLING	
START	FINISH
TIME 11:15	TIME 12:20
DATE 1/17/01	DATE 1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
35			SAND(SM), very fine-grained, slightly clayey, very loose to medium dense, bluish gray	10	34		
40			Percent finer than No. 200 = 22.5%	15	33		
45			few shells from 44'	16	33		
50				19	34		
55				21	36		
60			Bottom of Boring @ 60'	19	36		

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.55 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	12:30				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER: AMU-3

page 1 of 3

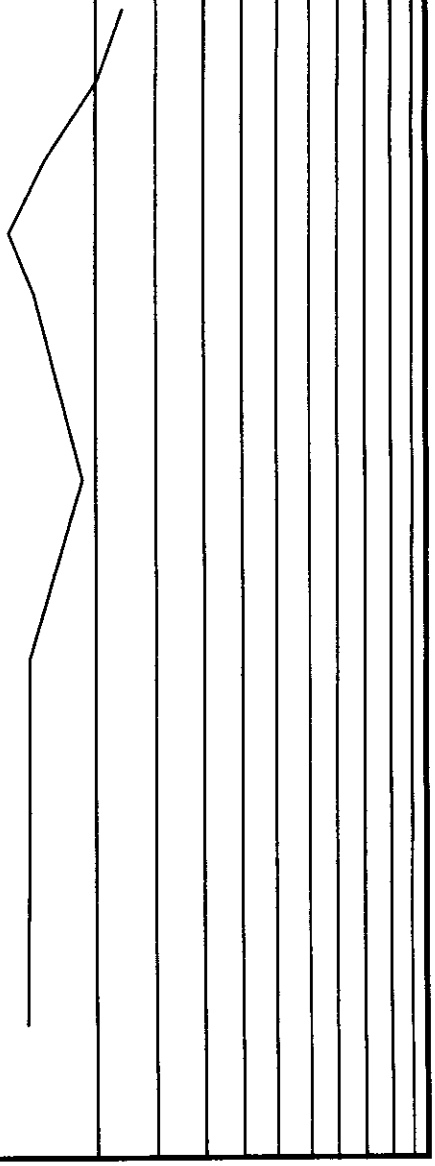
DRILLING START	DRILLING FINISH
TIME 12:00	TIME 1:30
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			SAND (SC), v. fine-grained, clayey, medium dense, gray	14			
			Percent finer than No. 200 = 36.2%	10	16	30	14
5			SAND(SM), v. fine-grained, silty, loose, gray with yellow mottles	7			
			Percent finer than No. 200 = 19.2%	4	36		
				6			
10			SAND(SM), very fine-grained, silty loose, bluish gray				
				9			
15			trace small shells and shell fragments				
				6			
20							
				6			
25							
				6			
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.55 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	12:30				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER AMU-3

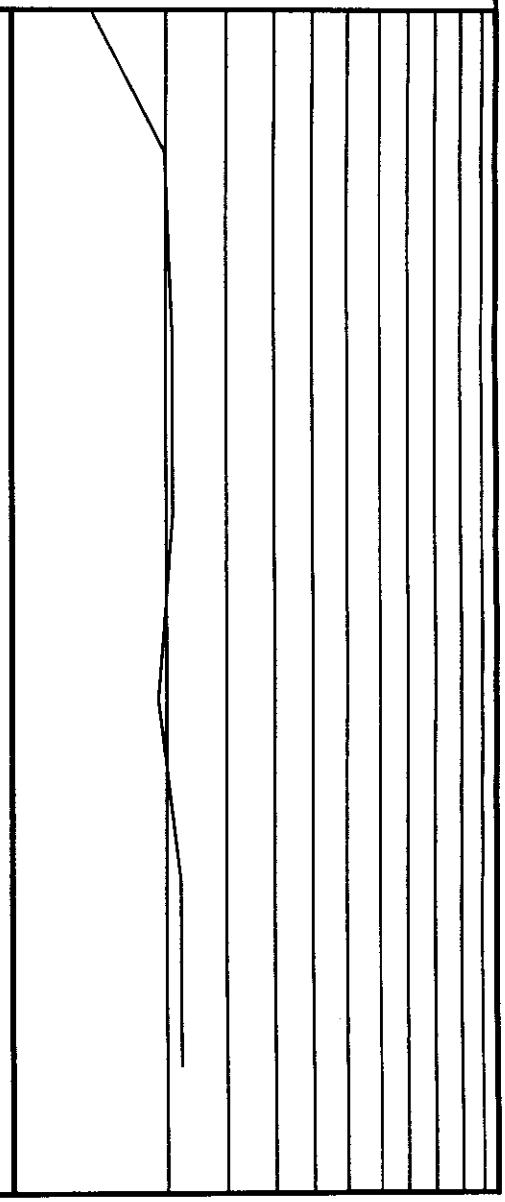
DRILLING START	DRILLING FINISH
TIME 12:00	TIME 1:30
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
35			(continued) SAND(SM), very fine-grained, silty loose to medium dense, bluish gray	10			
40				11			
45				11			
50				9			
55			slightly clayey @53'	12			
60			few shells @ 55'	12			

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:**6.55 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	12:30				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER AMU-3

DRILLING START	DRILLING FINISH
TIME 12:00	TIME 1:30
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE
65			(continued_ SAND(SM), very fine-grained, silty loose to medium dense, bluish gray	20				
			Bottom of Boring @ 65'					
70								
75								
80								
85								
90								

PENETRATION RESISTANCE: 10 20 30 40 60 80 100

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.96 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	10:30				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER: AMU-4

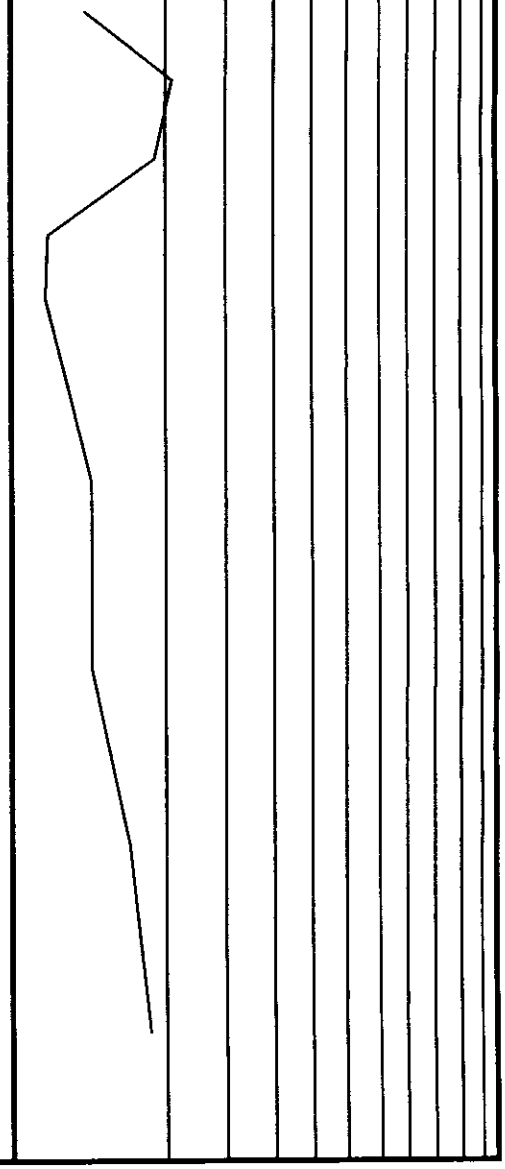
DRILLING	START	FINISH
TIME	10:15	10:50
DATE	1/18/01	1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 3" AC over 6.5" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			CLAY (CL), very sandy, silty, medium stiff to stiff, few rounded pebbles, mottled yellow and brown	5			
				11			
5			SAND (SM), very fine-grained, silty, very loose to loose, mottled orange and gray	9			
				3			
			SAND(SM), very fine-graned silty, very loose to loose, bluish gray	3			
10							
				6			
15							
				6			
20							
				8			
25							
				9			
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.96 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	10:30				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER AMU-4

DRILLING	
START	FINISH
TIME 10:15	TIME 10:50
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 3" AC over 6.5" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			SAND(SM), very fine-grained silty, very loose to loose, bluish gray	10				
35			Bottom of Boring @ 35'					
40								
45								
50								
55								
60								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.15 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0			
TIME	1:00			
DATE	1/17/01			
CASING DEPTH				

BORING NUMBER: AMU-5

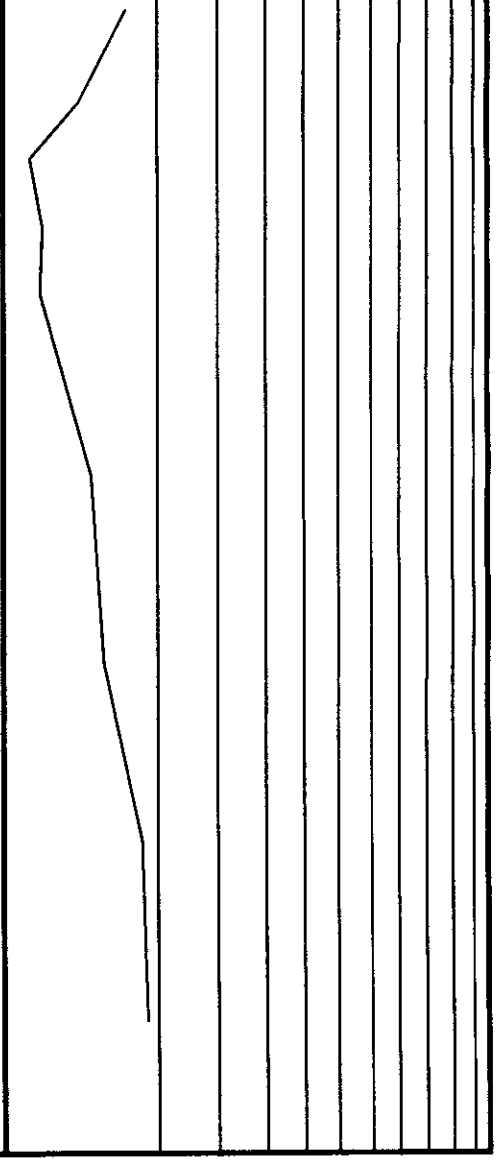
DRILLING START	DRILLING FINISH
TIME 12:45	TIME 1:15
DATE 1/17/01	DATE 1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 1/25" AC over 7" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			8.25" AC and concrete				
			SAND(SP)	8			
			SAND(SC)	4			
5			Percent finer than No. 200 = 23.5%	2	34		
				3			
			SAND(SM), v. fine-grained, silty, very loose to loose, bluish gray	3			
10							
			Percent finer than No. 200 = 14.9%	5	36		
15							
			trace shell fragments	6			
20							
				9			
25							
				9			
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.15 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0				
TIME	1:00				
DATE	1/17/01				
CASING DEPTH					

BORING NUMBER AMU-5

DRILLING	START	FINISH
TIME	12:45	1:15
DATE	1/17/01	1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 1.25" AC over 7" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE
			(continued) SAND(SM), v. fine-grained silty, very loose to loose, bluish gray					
			few shell fragments @34'	12				
35			Bottom of Boring @ 35'					
40								
45								
50								
55								
60			Bottom of Boring @ 60'					

PENETRATION RESISTANCE: 10 20 30 40 60 80 100

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.15 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	7.0				
TIME	10:00				
DATE	1/17/01				
CASING DEPTH					

BORING NUMBER: AMU-6

page 1 of 3

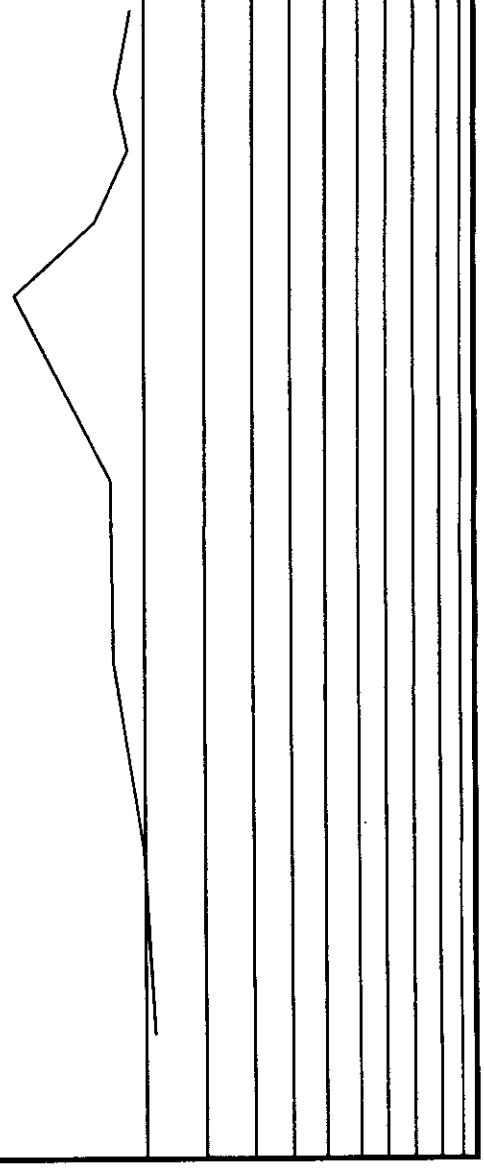
DRILLING	START	FINISH
TIME	9:20	11:00
DATE	1/17/01	1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 1.5" AC over 6" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
0			SAND (SC), fine grained, clayey, loose, mottled yellow, brown and gray	9			
				8	12		
5				9	24		
			Percent finer than No. 200 = 19.8%	7	29		
				2	33		
10			SAND (SM), very fine-grained, silty, loose to medium dense, bluish gray				
			Percent finer than No. 200 = 18.3%	8	33		
15							
				8	36		
20							
				10	33		
25			few shell fragments starting @ 24'				
				11	32		
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.15 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	7.0			
TIME	10:00			
DATE	1/17/01			
CASING DEPTH				

BORING NUMBER AMU-6

DRILLING	START	FINISH
TIME	9:20	11:00
DATE	1/17/01	1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 1.5" AC over 6" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
35			(continued) SAND(SM), very fine grained, silty loose to medium dense, bluish gray	14	32		
			few shell fragments				
40				18	30		
45				15	37		
50				12	38		
55				14	36		
60				13	39		

PENETRATION RESISTANCE
10 20 30 40 60 80 100

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.15 ft

DRILLING METHOD: mud rotary with tricone bit
started drilling @ 8 feet, used about 1/3 bag
of QuickGel
SAMPLING METHOD: Split Spoon Sampler
with 2 turns of rope on the cathead

WATER LEVEL	7.0				
TIME	10:00				
DATE	1/17/01				
CASING DEPTH					

BORING NUMBER
AMU-6

DRILLING	
START	FINISH
TIME 9:20	TIME 11:00
DATE 1/17/01	DATE 1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 1.5" AC over 6" concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			(continued) SAND(SM), very fine grained, silty, loose to medium dense, bluish gray	17	36			
65			Bottom of Boring @ 65'					
70								
75								
80								
85								
90								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.10 ft

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: AMU-7

					DRILLING START	DRILLING FINISH
WATER LEVEL	not encountered				TIME	TIME
TIME					2:30	2:45
DATE					DATE	DATE
CASING DEPTH					1/17/01	1/17/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 1.25 inches AC over 7 inches concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			Asphalt Surface (1.25 inches AC over 7 inches of concrete Clay (CL) very sandy, silty, with small pebbles brown and gray collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
10			maximim dry density = 118.5 pcf optimum moisture content = 11.5% CBR @ 0.1" = 11.0 CBR @ 0.2" = 12.8					
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.10 ft

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: AMU-8

		DRILLING START	DRILLING FINISH
WATER LEVEL	not encountered		
TIME		2:50	3:00
DATE		1/17/01	1/17/01
CASING DEPTH			

DRILL RIG: CME

DRILL ANGLE: 90°

SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 4.0 inches AC

DRILLING CONTRACTOR: Fishburne Drilling, Inc.

LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			Asphalt Surface (4.0 inches asphalt)					
			Clay (CL) very sandy, silty, brown and gray					
			collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
			maximim dry density = 119 pcf optimum moisture content = 13.4% CBR @ 0.1" = 4.2 CBR @ 0.2" = 3.8					
10								
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.44 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	7.5			
TIME	11:15			
DATE	1/18/01			
CASING DEPTH				

BORING NUMBER: AMU-9

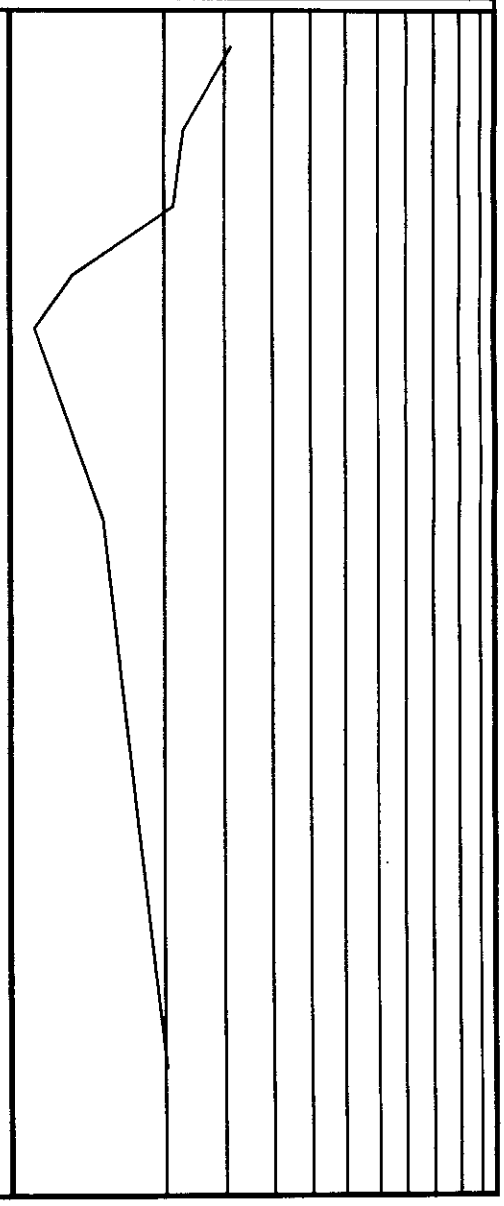
DRILLING START	DRILLING FINISH
TIME 11:00	TIME 11:45
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 3" AC
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
	SAND(SM), v. fine-grained, silty, medium dense, pieces of brick in sample, gray (fill)	22	12		
	CLAY (CL), very sandy, silty with few rounded pebbles, stiff, mottled yellow Percent finer than No. 200 = 56.1%	13	20	40	21
5		11	17		
	SAND(SM), silty, clayey, loose, mottled yellow and gray	4	12		
	SAND(SM), very fine-grained, silty, very loose to loose, bluish gray	2	35		
10	Percent finer than No. 200 = 14.8%				
		6	33		
15	Percent finer than No.200 = 15%				
			34		
20	Shelby Tube Sample 18-20' 28" of recovery				
			33		
25	Shelby Tube Sample 23-25' 30" of recovery				
		10	34		
30					

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.44 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	7.5				
TIME	11:15				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER AMU-9

DRILLING	START	FINISH
TIME	11:00	11:45
DATE	1/18/01	1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 3" AC
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			(continued) SAND(SM), very fine-grained, silty, very loose to loose, bluish gray	10	54			
35			Bottom of Boring @ 35'					
40								
45								
50								
55								
60								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.42 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

BORING NUMBER: LO-1

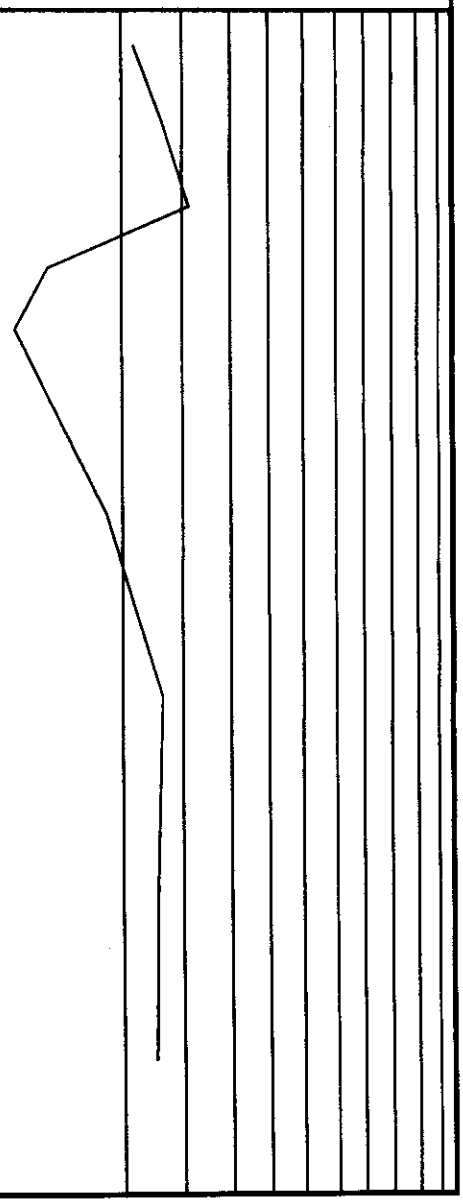
					DRILLING START	DRILLING FINISH
WATER LEVEL	8.0					
TIME	12:45				TIME 12:30	TIME 13:20
DATE	1/10/01				DATE 1/10/01	DATE 1/10/01
CASING DEPTH						

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
0			SAND(SC), very fine-grained, clayey medium dense, dark yellow brown Percent finer than No. 200 = 36.9%	12	13	38	19
				17			
5			SAND(SC), very fine-grained, clayey, medium dense, mottled yellow, brown gray Percent finer than No. 200 = 37.1%	22	13	63	36
			SAND (SC), fine grained, clayey, loose, yellow brown and red with trace angular quartz gravel	6			
				3			
10			SAND (SM), very fine-grained, silty with little shell fragments, loose to medium dense, dark blue gray				
			Percent finer than No. 200 = 9.5%	9	32		
15							
				16			
20							
				15			
25							
				15			
30			Bottom of Boring @ 30'				

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 4.52 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0				
TIME	11:00				
DATE	1/10/01				
CASING DEPTH					

BORING NUMBER LO-2

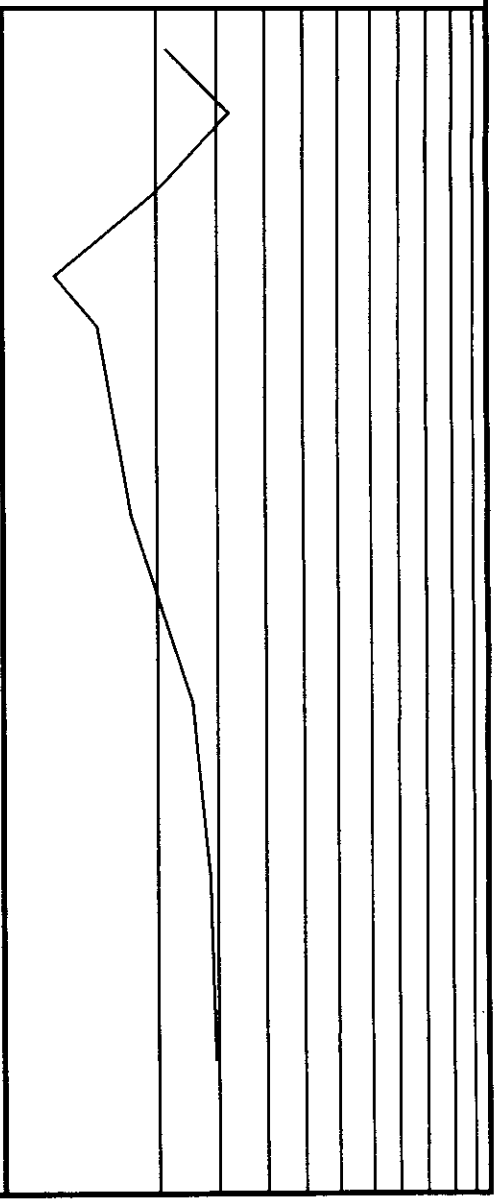
DRILLING	
START	FINISH
TIME 10:50	TIME 12:15
DATE 1/10/01	DATE 1/10/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			CLAY (CL), silty with little fine sand, stiff to very stiff, dark yellow brown (fill)	11	24		
				22	18		
5			SAND (SC), fine grained, clayey, loose, yellow brown	10	35		
			SAND (SM),v. fine-gr., silty, v. loose, petroleum odor, dark gray	3	37		
			SAND (SM), fine gr., slity, loose, green gray	6	34		
10			SAND (SM), very fine grained, silty, loose to medium dense, bluish gray				
				8	33		
15			few shell fragments				
				17	29		
20			Percent finer than No. 200 = 12.6%				
				19	29		
25							
				20	29		
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 4.52 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0				
TIME	11:00				
DATE	1/10/01				
CASING DEPTH					

BORING NUMBER LO-2

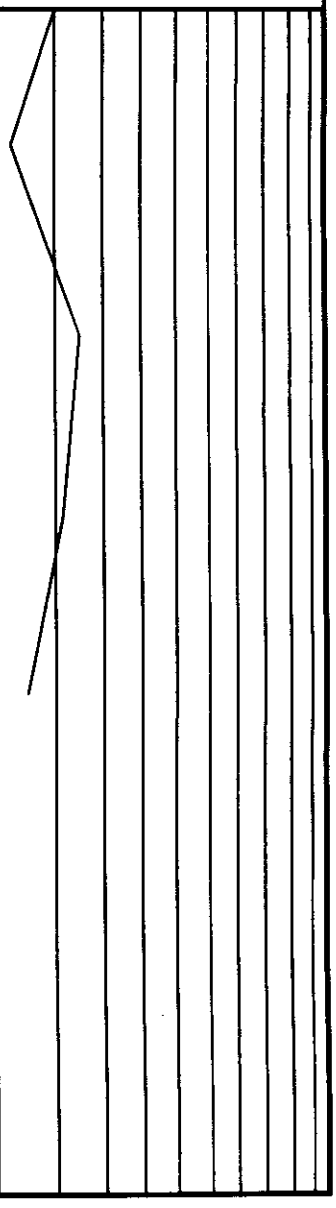
DRILLING	START	FINISH
TIME	10:50	12:15
DATE	1/10/01	1/10/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
35			(continued)SAND (SM), very fine grained, silty, loose to medium dense, bluish gray	12	32		
40			Percent fine than No. 200 = 17.1%	24	32		
45				21	34		
50				14	31		
			Bottom of Boring @ 50'				
55							
60							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.68 ft

DRILLING METHOD: mud rotary with tricone bit
started drilling @ 8 feet, used about 1/4 bag of QuickGel
SAMPLING METHOD: Split Spoon Sampler
with 2 turns of rope on the cathead

WATER LEVEL	6.0				
TIME	14:20				
DATE	1/10/01				
CASING DEPTH					

BORING NUMBER: LO-3

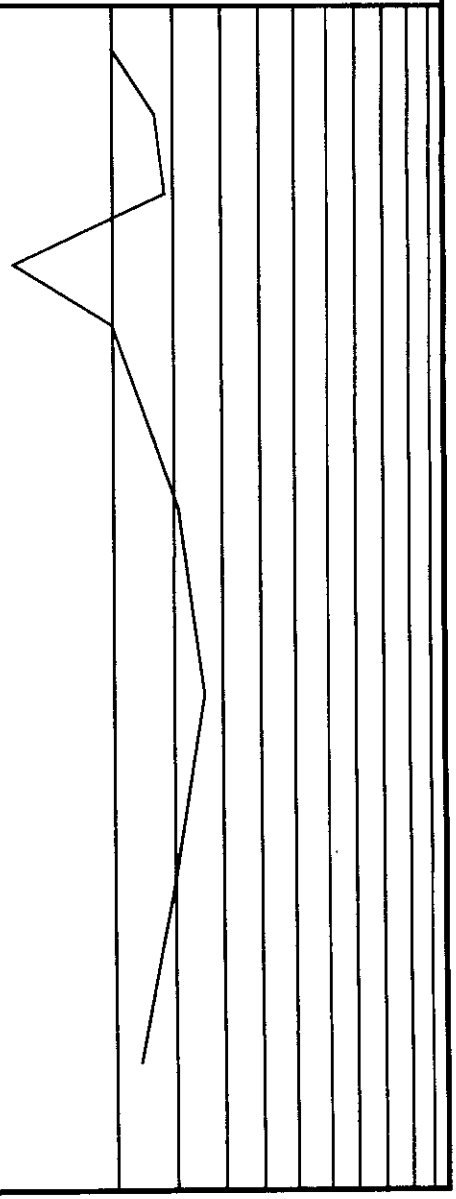
DRILLING	START	FINISH
TIME	14:10	14:45
DATE	1/10/01	1/10/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			SAND (SC), very fine grained, clayey medium dense with roots, mottled yellow, brown and gray Percent finer than No. 200 = 32.5%	10	13		
				17			
5			SAND (SC), very fine-grained, clayey, medium dense, reddish brown	19			
				3			
			SAND (SM), very fine-grained, silty, medium dense, bluish gray with trace shell fragments	10			
10							
				21	32		
15			Percent finer than No. 200 = 10.3%				
				26	30		
20			Percent finer than No. 200 = 10.3%				
				20			
25							
				13			
30			Bottom of Boring @ 30'				

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.85 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0				
TIME	9:50				
DATE	1/10/01				
CASING DEPTH					

BORING NUMBER: LO-4

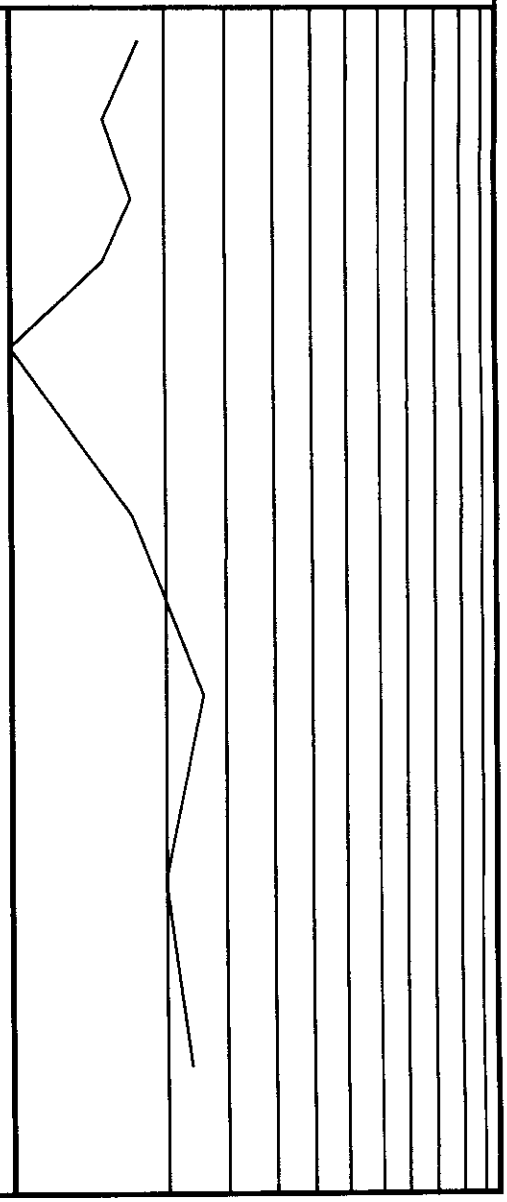
DRILLING START	DRILLING FINISH
TIME 9:40	TIME 10:50
DATE 1/10/01	DATE 1/10/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			SAND (SM), fine-grained, silty, loose, dark brown	8	13		
				5	22		
			CLAY (CL), v. sandy, silty, medium stiff, brown				
5				7	NR		
			SAND (SC), very fine-grained, clayey, dark yellow brown	5	31		
			Percent finer than No. 200 = 12.5%	WOH	39		
10			- dark gray				
			SAND(SM), v. fine-grained, silty, loose bluish gray	7	33		
15			Percent finer than No. 200 = 10.0%				
			SAND (SM), very fine-grained, silty, medium dense, bluish gray	16	28		
20							
				10	33		
25			trace shell fragments				
				13	33		
30			Bottom of Boring @ 30'				

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.: ****

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: LO-5

					DRILLING START	DRILLING FINISH
WATER LEVEL	not encountered				TIME	TIME
TIME						
DATE					DATE	DATE
CASING DEPTH						

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			surface grass Clay (CL) very sandy, silty, brown and gray collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
10			maximim dry density = 116 pcf optimum moisture content = 14.0% CBR @ 0.1" = 5.5 CBR @ 0.2" = 5.2					
15			** boring location not surveyed					
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** **

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: LO-6

					DRILLING START TIME	DRILLING FINISH TIME
WATER LEVEL	not encountered					
TIME						
DATE					DATE	DATE
CASING DEPTH						

DRILL RIG: CME

DRILL ANGLE: 90°

SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass

DRILLING CONTRACTOR: Fishburne Drilling, Inc.

LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			surface grass Clay (CL) very sandy, silty, brown and gray collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
10			maximim dry density = 117 pcf optimum moisture content = 12.5% CBR @ 0.1" = 5.5 CBR @ 0.2" = 6.5					
15			** Boring location not surveyed					
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.: ****

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

BORING NUMBER: LV-1

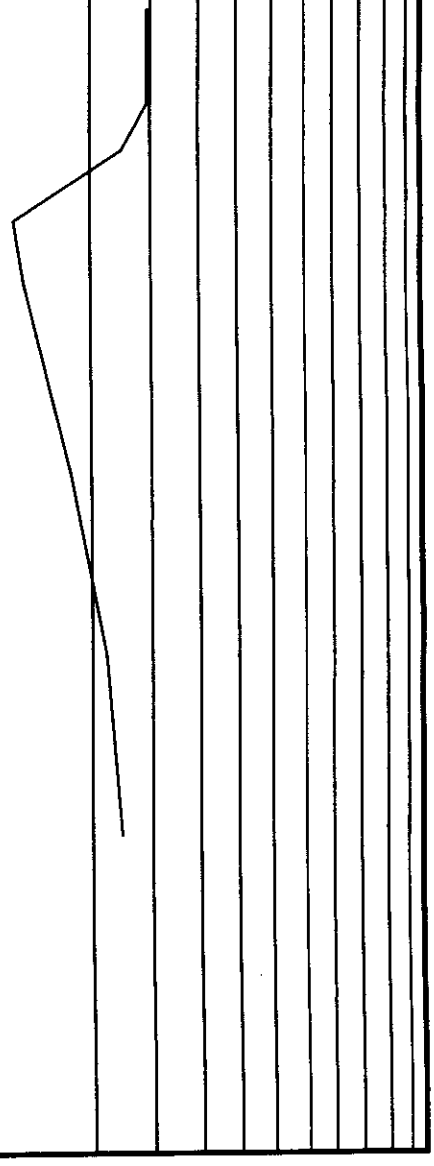
					DRILLING START	DRILLING FINISH
WATER LEVEL	6.0					
TIME	13:45				TIME 13:30	TIME 14:00
DATE	1/10/01				DATE 1/10/01	DATE 1/10/01
CASING DEPTH						

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			SAND (SC), fine grained, clayey, medium dense, gray/brown	19			
			CLAY (CL), sandy, stiff to very stiff, mottled yellow, brown and gray	19			
5				14			
			SAND (SC/SM), v. fine-grained, clayey, silty, mottled yellow, brown and gray	4			
				5			
10			SAND (SM), very fine-grained, silty, loose to medium dense, dark bluish, gray, with trace shell fragments				
				8			
15							
				12			
20							
				14			
25			Bottom of Boring @ 25'				
			** Boring location not surveyed				
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.97 ft

DRILLING METHOD: mud rotary with tricone bit
started drilling @ 8 feet, used about 1/4 bag of QuickGel
SAMPLING METHOD: Split Spoon Sampler
with 2 turns of rope on the cathead

WATER LEVEL	5.5			
TIME	15:15			
DATE	1/10/01			
CASING DEPTH				

BORING NUMBER: VT-1

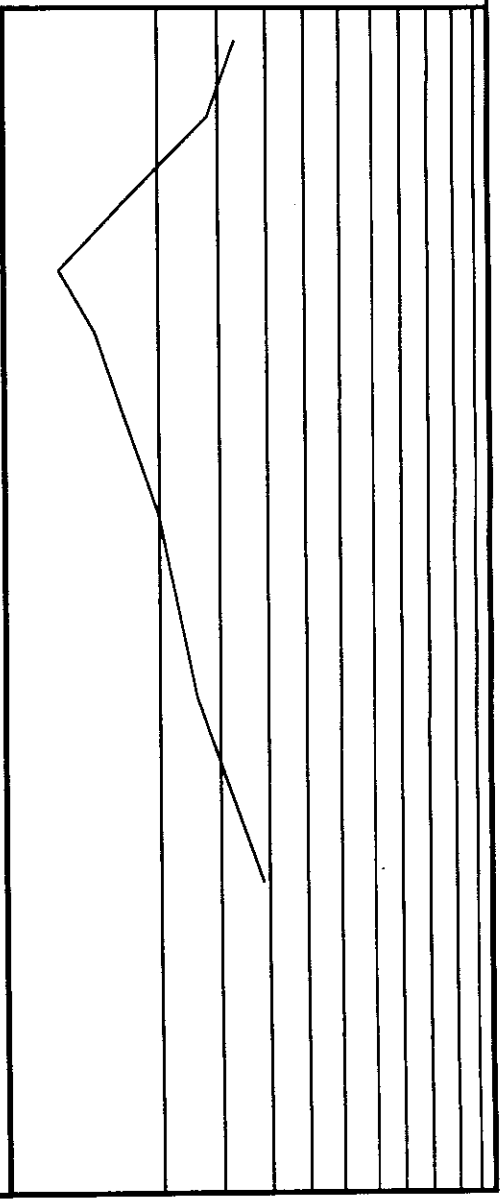
DRILLING	START	FINISH
TIME	15:00	15:30
DATE	1/10/01	1/10/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			CLAY (CL), sandy, silty with angular to subrounded gravel, very stiff, dark gray (fill)	23	10		
			SAND (SC), fine-grained, clayey, medium dense to very loose, grayish brown	18	17		
5				8	25		
			Percent finer than No. 200 = 36.5%	3			
				5	31		
10			SAND (SM/SC), very fine-grained, silty, clayey with crushed shell fragments, loose to medium dense, dark bluish gray				
			Percent finer than No. 200 = 14.0%	10	34		
15							
				16	30		
20							
				29	27		
25			Bottom of Boring @ 25'				
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 6.12 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

BORING NUMBER: VT-2

					DRILLING START	DRILLING FINISH
WATER LEVEL	7.0					
TIME	9:30				TIME 9:15	TIME 10:00
DATE	1/15/01				DATE 1/15/01	DATE 1/15/01
CASING DEPTH						

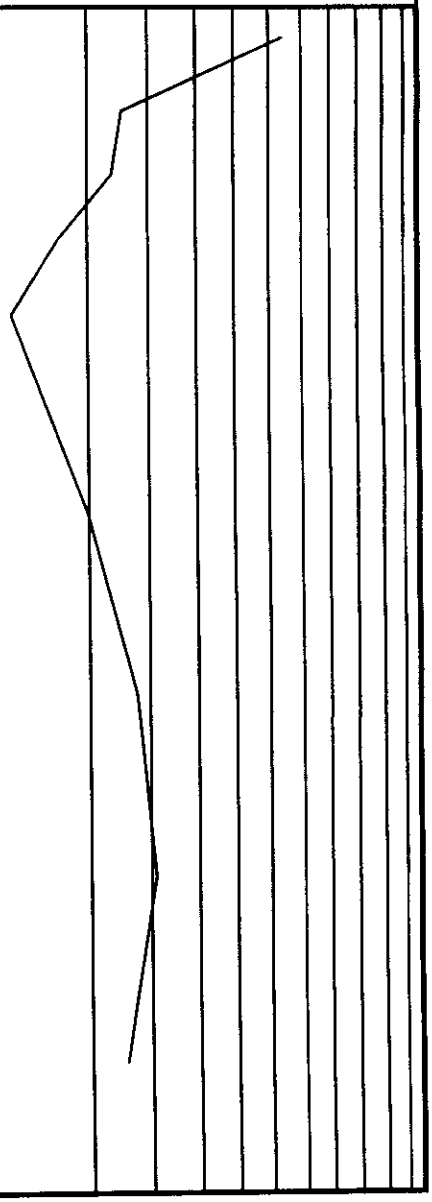
DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
0							
5			SAND(SC), fine -grained, very clayey siilty, with angular gravel to 1/2", hard to stiff Percent finer than No. 200 = 44.8%	53 15 13	18		
10			SAND (SM), very fine-grained, silty, loose to medium dense, dark bluish gray	8 4 10			
15				18			
20				21			
25				15			
30			Bottom of Boring @ 30'				

PENETRATION RESISTANCE

10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.68 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	not encountered			
TIME				
DATE				
CASING DEPTH				

BORING NUMBER: BO-1

DRILLING START TIME	DRILLING FINISH TIME
DATE	DATE

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: concrete paving
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			10.5" of concrete over CLAY(CL), silty, sandy, brown					
			collected bulk sample from 2 to 4'					
5			Bottom of Boring @ 5'					
10			maximim dry density = 113.9 pcf optimum moisture content = 15% CBR @ 0.1" = 10.4 CBR @ 0.2" = 9.2					
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.90 ft

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

with 2 turns of rope on the cathead

WATER LEVEL	not encountered			
TIME				
DATE				
CASING DEPTH				

BORING NUMBER: BO-1A

DRILLING START TIME	DRILLING FINISH TIME
DATE	DATE

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: concrete paving
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			10.0" of concrete over CLAY(CL), very sandy, silty brown Petrolenm odor collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
10			maximim dry density = 114 pcf optimum moisture content = 16% CBR @ 0.1" = 5.9 CBR @ 0.2" = 4.9					
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 8.55 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0				
TIME	12:30				
DATE	1/16/01				
CASING DEPTH					

BORING NUMBER BO-2

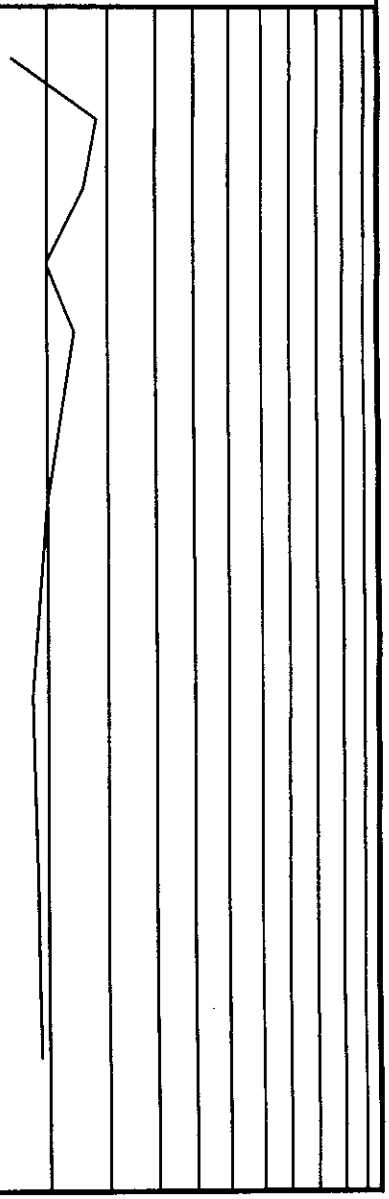
DRILLING	
START	FINISH
TIME 12:15	TIME 1:10
DATE 1/16/01	DATE 1/16/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 7" concrete over 2" of 1"-stone
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			concrete, stone and sand to 1.5'	8	18		
			SAND(SC), v. fine-grained, very clayey medium dense, with few subrounded pebbles, medium brown	18	17	38	22
5			Percent finer than No. 200 = 48.7% Petroleum odor @ 5 to 8'	15	21		
				10	31		
			SAND(SM), v. fine-grained, silty, medium dense, some shell fragments, yellow brown	13	30		
10			Percent finer than No. 200 = 19.5%				
			SAND(SM), very fine-grained, silty, loose, with some shell fragments (whole shells to 1/4" and pieces of large shells), bluish gray	10	32		
15							
				8	33		
20							
			trace shells from 24'	9	33		
25							
				9	32		
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 8.55 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0			
TIME	12:30			
DATE	1/16/01			
CASING DEPTH				

BORING NUMBER BO-2

DRILLING START	DRILLING FINISH
TIME 12:15	TIME 1:10
DATE 1/16/01	DATE 1/16/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS 7" concrete over 2" of 1"-stone
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE
35			(continued) SAND(SM), very fine grained, silty, loose, with some shell fragments (whole shells to 1/4" and pieces of large shells), bluish gray	19				
40			uniform texture from 25' to 45'	12				
45			Bottom of Boring @ 45'	14				
50								
55								
60								

PENETRATION RESISTANCE: 10 20 30 40 60 80 100

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION: Base Operations Bldg.

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.87 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	5.0				
TIME	12:15				
DATE	1/16/01				
CASING DEPTH					

BORING NUMBER: BO-3

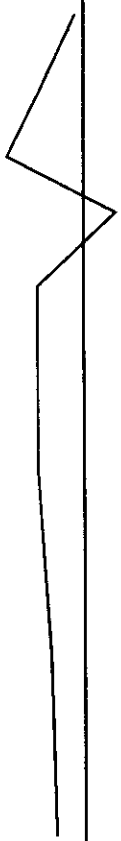
DRILLING	START	FINISH
TIME	11:50	1:30
DATE	1/16/01	1/16/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 4.5" of concrete
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			4.5" concrete CLAY (CL), v. silty with pieces of asphalt, stiff, petroleum odor (fill)	9 7			
5			SAND(SM), very fine-grained, silty, with some shell fragments, loose to medium dense, petroleum odor, mottled yellow brown Percent finer than No. 200 = 19.1%	4 14 7	30		
10							
15			SAND(SM), very fine-grained, silty with some shell fragments, loose, bluish, gray Percent finer than No. 200 = 14%	7	32		
20			trace shells below 18'	8			
25			Bottom of boring @ 25'	8			
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.: ****

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: BO-4

					DRILLING START TIME	DRILLING FINISH TIME
WATER LEVEL	not encountered					
TIME						
DATE					DATE	DATE
CASING DEPTH						

DRILL RIG: CME

DRILL ANGLE: 90°

SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: 3.5 inches of asphalt

DRILLING CONTRACTOR: Fishburne Drilling, Inc.

LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			3.5 inches of asphalt SAND (SC) very clayey, silty brown collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5' ** Boring location covered with gravel pile when area was surveyed.					
10								
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.81 ft

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: BO-5

					DRILLING START	DRILLING FINISH
WATER LEVEL	not encountered				TIME	TIME
TIME						
DATE					DATE	DATE
CASING DEPTH						

DRILL RIG: CME

DRILL ANGLE: 90°

SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass

DRILLING CONTRACTOR: Fishburne Drilling, Inc.

LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			surface grass SAND (SC) very clayey, silty brown					
			collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
			maximim dry density = 108.5 pcf optimum moisture content = 18% CBR @ 0.1" = 5.0 CBR @ 0.2" = 4.4					
10								
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 7.13 ft

DRILLING METHOD: continuous flight auger

SAMPLING METHOD: Grab

BORING NUMBER: BO-6

					DRILLING START TIME	DRILLING FINISH TIME
WATER LEVEL	not encountered					
TIME						
DATE					DATE	DATE
CASING DEPTH						

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: grass
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX	PENETRATION RESISTANCE (10 20 30 40 60 80 100)
			surface grass Clay (CL) very sandy, silty, brown and gray collected bulk sample from 1 to 5'					
5			Bottom of Boring @ 5'					
10			maximim dry density = 115 pcf optimum moisture content = 13.5% CBR @ 0.1" = 6.4 CBR @ 0.2" = 5.7					
15								
20								
25								
30								

SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.69 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/4 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	8.0				
TIME	9:15				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER PH-1

page 1 of 2

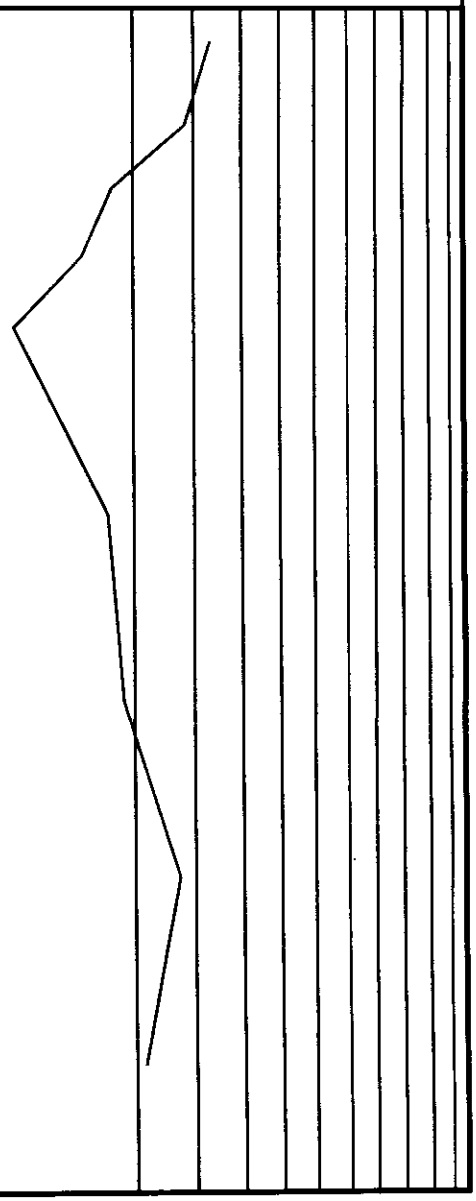
DRILLING START	DRILLING FINISH
TIME 9:00	TIME 10:00
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS: Asphalt parking lot 3" AC
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
			SAND (SM), very fine-grained, silty, with few rounded pebbles, medium dense olive gray (fill)	23	10		
				18	15		
5			SAND (SM), v. fine-grained, silty with fine roots to 1/4" diameter, loose, dark gray	8	20		
				6	22		
			SAND (SM), v. fine-grained, silty, v. loose, gray Percent finer than No. 200 = 27.2%	2	31		
10			SAND(SM), very fine-grained, silty, clayey, very loose to loose, gray				
			Percent finer than No. 200 = 21.7%	8	36		
15			becoming blue gray with depth				
				9	35		
20							
				17	34		
25			trace shells in sample @ 25'				
				11	33		
30							

PENETRATION RESISTANCE
10 20 30 40 60 80 100



SOIL BOREHOLE LOG

SITE NAME AND LOCATION:
F-22 Beddown Facility
Langley Air Force Base
Hampton, Virginia

BORING LOCATION:

PROJECT NUMBER: 00-062

DATUM: FT MSL **GROUND ELE.:** 5.69 ft

DRILLING METHOD: mud rotary with tricone bit started drilling @ 8 feet, used about 1/3 bag of QuickGel

SAMPLING METHOD: Split Spoon Sampler with 2 turns of rope on the cathead

WATER LEVEL	8.0				
TIME	9:15				
DATE	1/18/01				
CASING DEPTH					

BORING NUMBER PH-1

page 2 of 2

DRILLING START	DRILLING FINISH
TIME 9:00	TIME 10:00
DATE 1/18/01	DATE 1/18/01

DRILL RIG: CME
DRILL ANGLE: 90°
SAMPLE HAMMER TYPE: 140# safety hammer

SURFACE CONDITIONS Asphalt parking lot 3" of AC
DRILLING CONTRACTOR: Fishburne Drilling, Inc.
LOGGED BY: M. Thomas

DEPTH IN FEET	SAMPLER	LITHOLOGY	DESCRIPTION OF MATERIAL	BLOWS per FOOT (N)	TEST RESULTS: WATER CONTENT %	TEST RESULTS: LIQUID LIMIT %	TEST RESULTS: PLASTICITY INDEX
35			SAND(SM), very fine-grained, silty, clayey, very loose to loose, gray	10	34		
			few shell fragments encountered in samples to bottom of boring				
40				13	38		
45				14	36		
50			Bottom of Boring @ 50'	13	36		
55							
60							

PENETRATION RESISTANCE
10 20 30 40 60 80 100

APPENDIX B

LABORATORY TEST RESULTS

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID L0-1
Sample Depth 0-2'
Visual Sample Description Brown Clayey SAND

Natural Moisture Content

Pan ID	7	
Pan Wt	192.33	grams
Pan + Soil (wet)	335.72	grams
Pan + Soil (dry)	318.79	grams
Natural Moisture Content	*13.4%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	272.11	grams
Percent Passing No. 200 Sieve	36.9%	
Pan + Soil retained on No. 4 sieve (dry)	203.00	grams
Percent Passing No. 4 Sieve	91.6%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows	19	26	33
Pan ID	65	62	121
Pan Wt	10.98	10.90	11.24
Pan + Soil (wet)	16.54	17.56	16.79
Pan + Soil (dry)	14.98	15.74	15.29
Moisture Content	39%	38%	37%
Liquid Limit	38	38	38
Liquid Limit	*38*		

Plastic Limit

Pan ID	49	29
Pan Weight	2.39	2.39
Pan + Soil (wet)	12.73	13.44
Pan + Soil (dry)	11.10	11.72
Moisture Content	19%	18%
Plastic Limit	*19*	
Plastic Index	*19*	

USCS Classification

Group Symbol	SC
Group Name	Clayey SAND

Grain Size Distribution Calculations

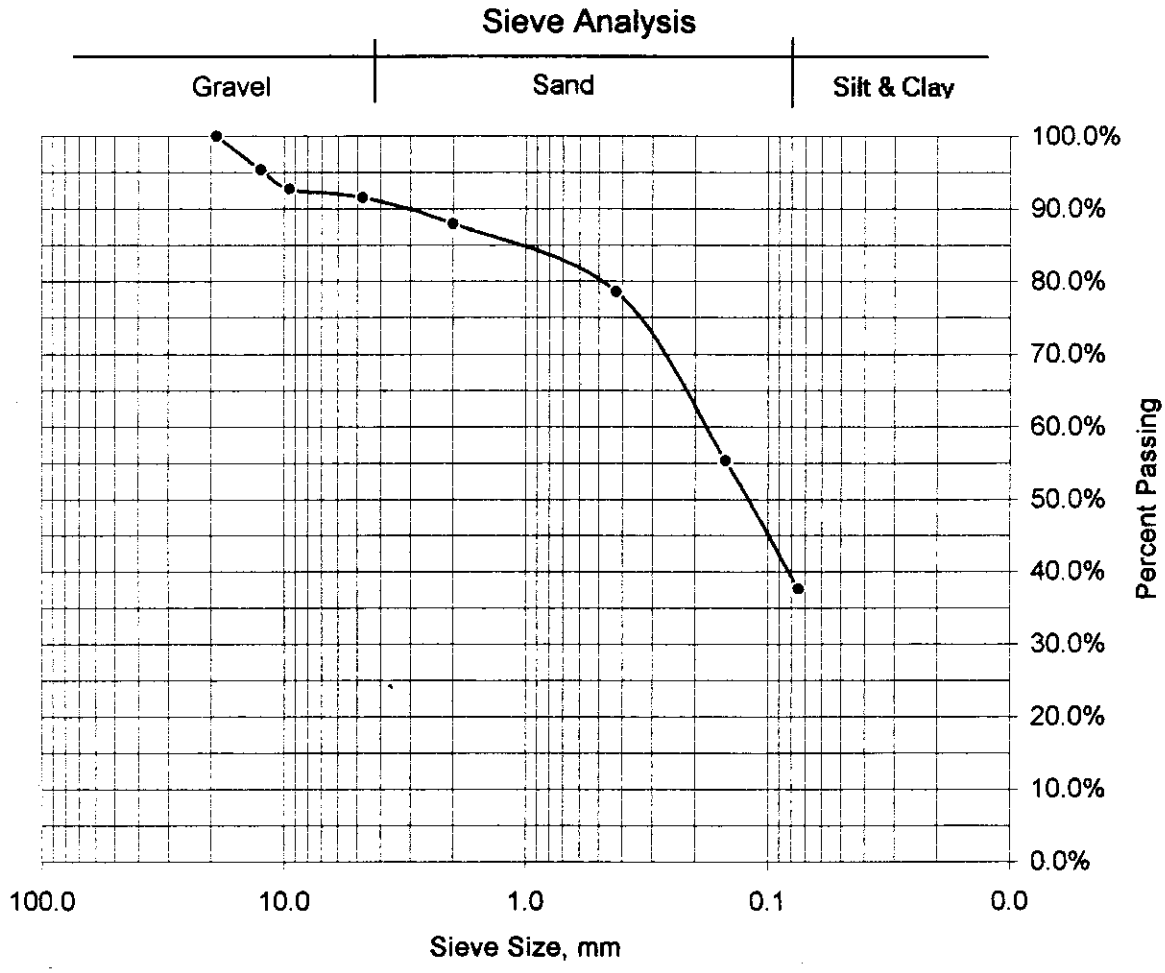
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID L0-1
Sample Depth 0-2'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	5.85	4.6%	12.5	95.4%
3/8"	3.34	2.6%	9.5	92.7%
No. 4	1.48	1.2%	4.75	91.6%
No. 10	4.63	3.7%	2.0	87.9%
No. 40	11.74	9.3%	0.425	78.6%
No. 100	29.48	23.3%	0.15	55.3%
No. 200	22.26	17.6%	0.075	37.7%
Pan	0.80	0.6%		
Total	79.58	62.3%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID L0-1
Sample Depth 4'-6'
Visual Sample Description Brown Clayey SAND

Natural Moisture Content

Pan ID	37	
Pan Wt	193.57	grams
Pan + Soil (wet)	328.14	grams
Pan + Soil (dry)	312.72	grams
Natural Moisture Content	*12.9%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	268.50	grams
Percent Passing No. 200 Sieve	37.1%	
Pan + Soil retained on No. 4 sieve (dry)	204.00	grams
Percent Passing No. 4 Sieve	91.2%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows	35	26	19
Pan ID	93	105	103
Pan Wt	30.12	29.31	27.4
Pan + Soil (wet)	39.93	37.43	34.67
Pan + Soil (dry)	36.25	34.31	31.83
Moisture Content	60%	62%	64%
Liquid Limit	63	63	62
Liquid Limit	*63*		

Plastic Limit

Pan ID	D	B
Pan Weight	2.42	2.42
Pan + Soil (wet)	13.40	12.01
Pan + Soil (dry)	11.10	10.03
Moisture Content	26%	26%
Plastic Limit	*26*	
Plastic Index	*36*	

USCS Classification

Group Symbol SC
Group Name Clayey SAND

Grain Size Distribution Calculations

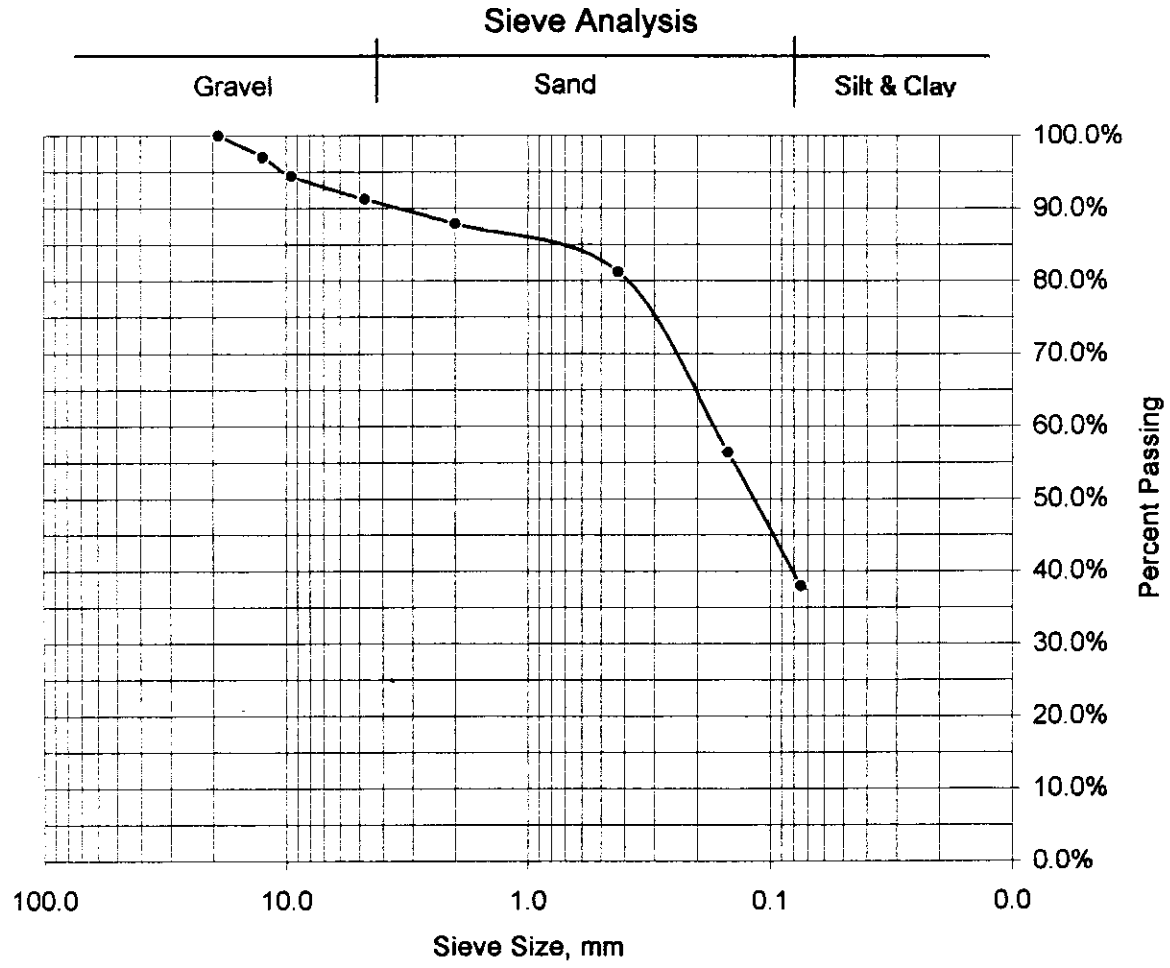
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID L0-1
Sample Depth 4'-6'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	3.51	2.9%	12.5	97.1%
3/8"	3.15	2.6%	9.5	94.4%
No. 4	3.77	3.2%	4.75	91.2%
No. 10	4.00	3.4%	2.0	87.9%
No. 40	7.96	6.7%	0.425	81.2%
No. 100	29.58	24.8%	0.15	56.4%
No. 200	21.94	18.4%	0.075	38.0%
Pan	0.50	0.4%		
Total	74.41	62.0%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-1
Sample Depth 13'-15'
Visual Sample Description Brown Silty SAND

Natural Moisture Content

Pan ID	33
Pan Wt	193.66 grams
Pan + Soil (wet)	286.18 grams
Pan + Soil (dry)	263.67 grams
Natural Moisture Content	*32.2%*

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	257.03 grams
Percent Passing No. 200 Sieve	9.5%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 0'-2'

Natural Moisture Content

Pan ID	A-111
Pan Wt	8.16 grams
Pan + Soil (wet)	73.82 grams
Pan + Soil (dry)	60.94 grams
Natural Moisture Content	24.4%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 2'-4'

Natural Moisture Content

Pan ID	A-110
Pan Wt	8.15 grams
Pan + Soil (wet)	162.29 grams
Pan + Soil (dry)	139.32 grams
Natural Moisture Content	*17.5%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 4'-6'

Natural Moisture Content

Pan ID	A-105
Pan Wt	8.12 grams
Pan + Soil (wet)	134.56 grams
Pan + Soil (dry)	101.50 grams
Natural Moisture Content	*35.4%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 6'-8'

Natural Moisture Content

Pan ID	A-100
Pan Wt	8.14 grams
Pan + Soil (wet)	137.56 grams
Pan + Soil (dry)	102.82 grams
Natural Moisture Content	*36.7%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 8'-10'

Natural Moisture Content

Pan ID	A-102
Pan Wt	8.19 grams
Pan + Soil (wet)	129.86 grams
Pan + Soil (dry)	98.74 grams
Natural Moisture Content	34.4%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 13'-15'

Natural Moisture Content

Pan ID	A-104	
Pan Wt	8.31	grams
Pan + Soil (wet)	134.45	grams
Pan + Soil (dry)	103.29	grams
Natural Moisture Content	*32.8%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 18'-20'
Visual Sample Description Gray Silty SAND

Natural Moisture Content

Pan ID	26	
Pan Wt	194.58	grams
Pan + Soil (wet)	327.69	grams
Pan + Soil (dry)	297.70	grams
Natural Moisture Content	*29.1%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	284.74	grams
Percent Passing No. 200 Sieve	12.6%	
Pan + Soil retained on No. 4 sieve (dry)	194.58	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows			
Pan ID			
Pan Wt	Non-Plastic		
Pan + Soil (wet)			
Pan + Soil (dry)			
Moisture Content	0%	0%	0%
Liquid Limit	0	NA	NA
Liquid Limit	*0*		

Plastic Limit

Pan ID		
Pan Weight	Non-Plastic	
Pan + Soil (wet)		
Pan + Soil (dry)		
Moisture Content	0%	0%
Plastic Limit	*0*	
Plastic Index	*0*	

USCS Classification

Group Symbol	SM
Group Name	Silty SAND

Grain Size Distribution Calculations

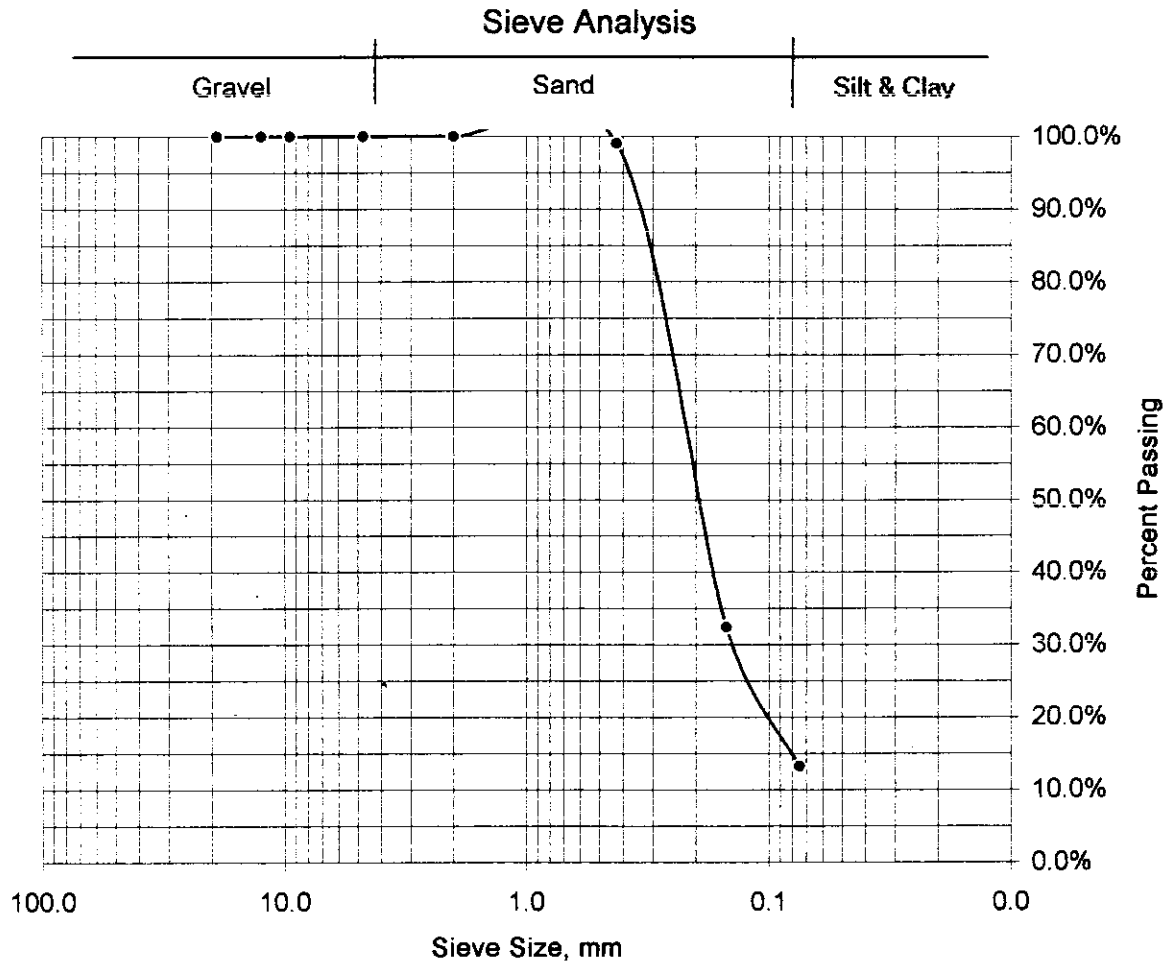
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 18'-20'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	0.00	0.0%	2.0	100.0%
No. 40	1.00	1.0%	0.425	99.0%
No. 100	68.68	66.6%	0.15	32.4%
No. 200	19.79	19.2%	0.075	13.2%
Pan	0.53	0.5%		
Total	90.00	86.8%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	A-107	
Pan Wt	8.13	grams
Pan + Soil (wet)	104.83	grams
Pan + Soil (dry)	82.88	grams
Natural Moisture Content	*29.4%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	A-101	
Pan Wt	8.17	grams
Pan + Soil (wet)	124.71	grams
Pan + Soil (dry)	98.71	grams
Natural Moisture Content	*28.7%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 33'-35'

Natural Moisture Content

Pan ID	A-106
Pan Wt	8.30 grams
Pan + Soil (wet)	145.40 grams
Pan + Soil (dry)	112.40 grams
Natural Moisture Content	*31.7%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 38'-40'
Visual Sample Description Gray Silty SAND

Natural Moisture Content

Pan ID	15
Pan Wt	188.26 grams
Pan + Soil (wet)	355.36 grams
Pan + Soil (dry)	315.21 grams
Natural Moisture Content	*31.6%*

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	293.52 grams
Percent Passing No. 200 Sieve	17.1%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 43'-45'

Natural Moisture Content

Pan ID	A-103
Pan Wt	8.26 grams
Pan + Soil (wet)	166.26 grams
Pan + Soil (dry)	126.35 grams
Natural Moisture Content	*33.8%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID LO-2
Sample Depth 48'-50'

Natural Moisture Content

Pan ID	A-109
Pan Wt	8.26 grams
Pan + Soil (wet)	124.97 grams
Pan + Soil (dry)	97.12 grams
Natural Moisture Content	*31.3%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	LO-3
Sample Depth	0'-2'
Visual Sample Description	Brown Clayey SAND

Natural Moisture Content

Pan ID	23	
Pan Wt	193.96	grams
Pan + Soil (wet)	339.64	grams
Pan + Soil (dry)	323.09	grams
Natural Moisture Content	*12.8%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	281.12	grams
Percent Passing No. 200 Sieve	32.5%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	LO-3
Sample Depth	13'-15'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	10	
Pan Wt	184.05	grams
Pan + Soil (wet)	300.95	grams
Pan + Soil (dry)	272.89	grams
Natural Moisture Content	*31.6%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	263.78	grams
Percent Passing No. 200 Sieve	10.3%	
Pan + Soil retained on No. 4 sieve (dry)	184.05	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows			
Pan ID			
Pan Wt	Non-Plastic		
Pan + Soil (wet)			
Pan + Soil (dry)			
Moisture Content	0%	0%	0%
Liquid Limit	0	NA	NA
Liquid Limit	*0*		

Plastic Limit

Pan ID		
Pan Weight	Non-Plastic	
Pan + Soil (wet)		
Pan + Soil (dry)		
Moisture Content	0%	0%
Plastic Limit	*0*	
Plastic Index	*0*	

USCS Classification

Group Symbol	SM
Group Name	Silty SAND

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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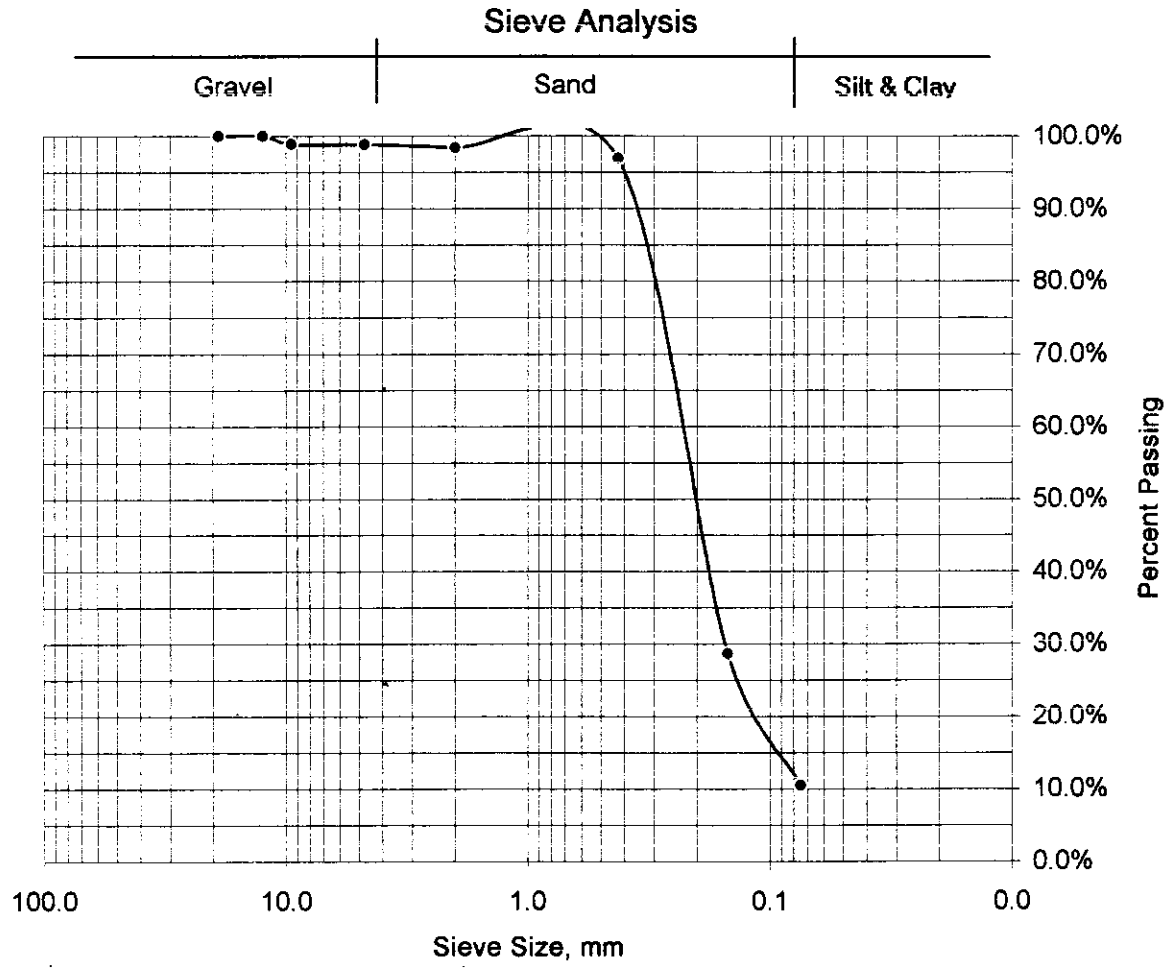
Sample ID LO-3
Sample Depth 13'-15'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.97	1.1%	9.5	98.9%
No. 4	0.05	0.1%	4.75	98.9%
No. 10	0.45	0.5%	2.0	98.3%
No. 40	1.28	1.4%	0.425	96.9%
No. 100	60.58	68.2%	0.15	28.7%
No. 200	16.14	18.2%	0.075	10.5%
Pan	0.07	0.1%		
Total	79.54	89.5%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	LO-3
Sample Depth	18'-20'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	2	
Pan Wt	196.21	grams
Pan + Soil (wet)	352.45	grams
Pan + Soil (dry)	316.64	grams
Natural Moisture Content	*29.7%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	304.29	grams
Percent Passing No. 200 Sieve	10.3%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID LO-4
Sample Depth 0'-2'

Natural Moisture Content

Pan ID	A-108
Pan Wt	8.19 grams
Pan + Soil (wet)	162.15 grams
Pan + Soil (dry)	144.33 grams
Natural Moisture Content	*13.1%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID LO-4
Sample Depth 2'-4'

Natural Moisture Content

Pan ID	39
Pan Wt	193.02 grams
Pan + Soil (wet)	297.61 grams
Pan + Soil (dry)	278.63 grams
Natural Moisture Content	22.2%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID LO-4
Sample Depth 6'-8'

Natural Moisture Content

Pan ID	28
Pan Wt	193.21 grams
Pan + Soil (wet)	346.24 grams
Pan + Soil (dry)	310.30 grams
Natural Moisture Content	*30.7%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	LO-4
Sample Depth	8'-10'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	18	
Pan Wt	189.07	grams
Pan + Soil (wet)	278.82	grams
Pan + Soil (dry)	253.69	grams
Natural Moisture Content	*38.9%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	245.60	grams
Percent Passing No. 200 Sieve	12.5%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID LO-4
Sample Depth 13'-15'
Visual Sample Description Gray Silty SAND

Natural Moisture Content

Pan ID	21
Pan Wt	193.76 grams
Pan + Soil (wet)	347.21 grams
Pan + Soil (dry)	309.09 grams
Natural Moisture Content	*33.1%*

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	297.53 grams
Percent Passing No. 200 Sieve	10.0%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID LO-4
Sample Depth 18'-20'

Natural Moisture Content

Pan ID	30
Pan Wt	193.90 grams
Pan + Soil (wet)	323.00 grams
Pan + Soil (dry)	294.50 grams
Natural Moisture Content	*28.3%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID LO-4
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	36
Pan Wt	193.90 grams
Pan + Soil (wet)	336.95 grams
Pan + Soil (dry)	301.80 grams
Natural Moisture Content	*32.6%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID LO-4
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	8
Pan Wt	187.28 grams
Pan + Soil (wet)	332.51 grams
Pan + Soil (dry)	296.41 grams
Natural Moisture Content	*33.1%*

Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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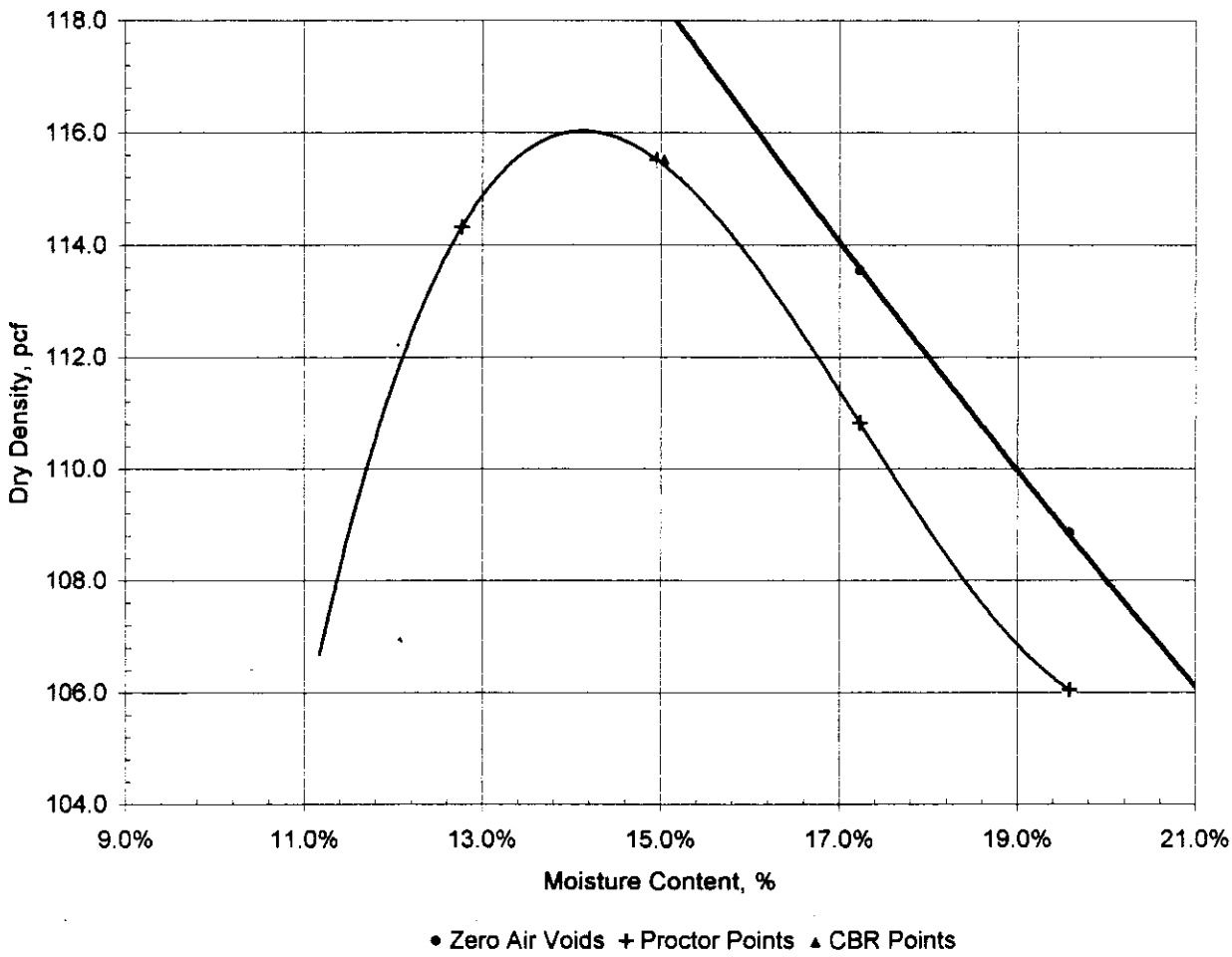
Soil and Test Method Data

Sample ID	L0-5
Sample Depth	2'-4'
Sample Classification	#DIV/0!
USCS Group Symbol	#DIV/0!
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	12.8%	15.0%	17.2%	19.6%	
Dry Density, pcf	114.3	115.5	110.8	106.0	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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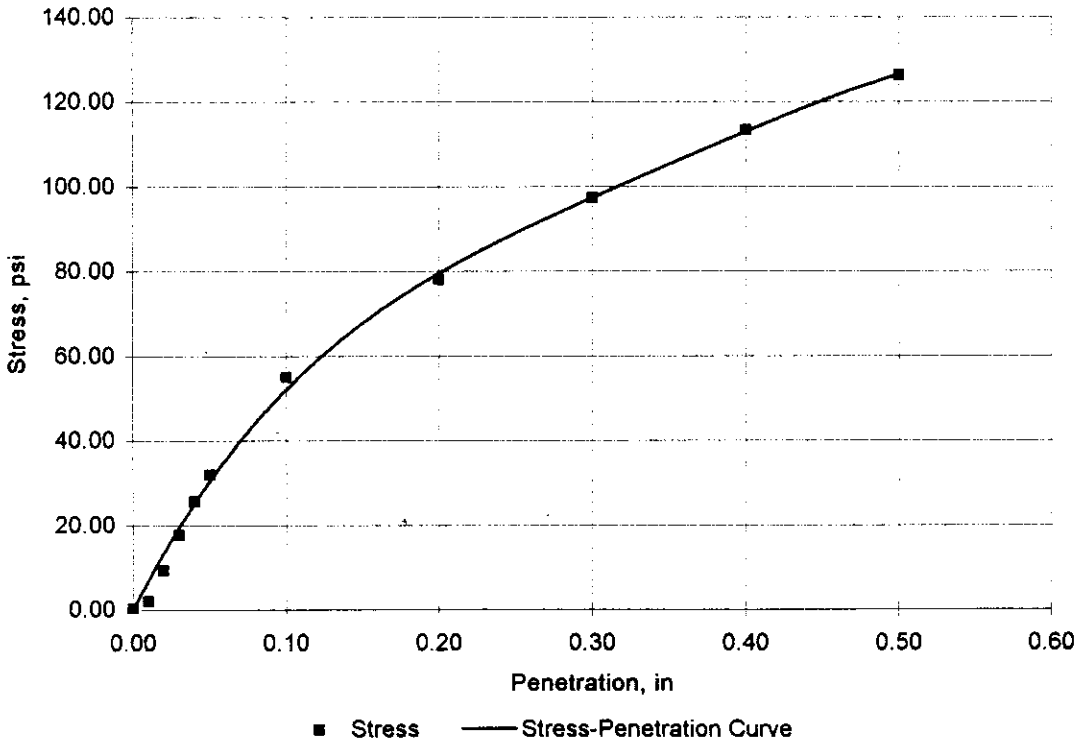
Soil and Test Method Data

Sample ID	L0-5
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	15.0%
Compacted Dry Density	115.5
Percent Compaction	100%
Percent Swell	0.3%
CBR @ 0.1"	5.5
CBR @ 0.2"	5.2



Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

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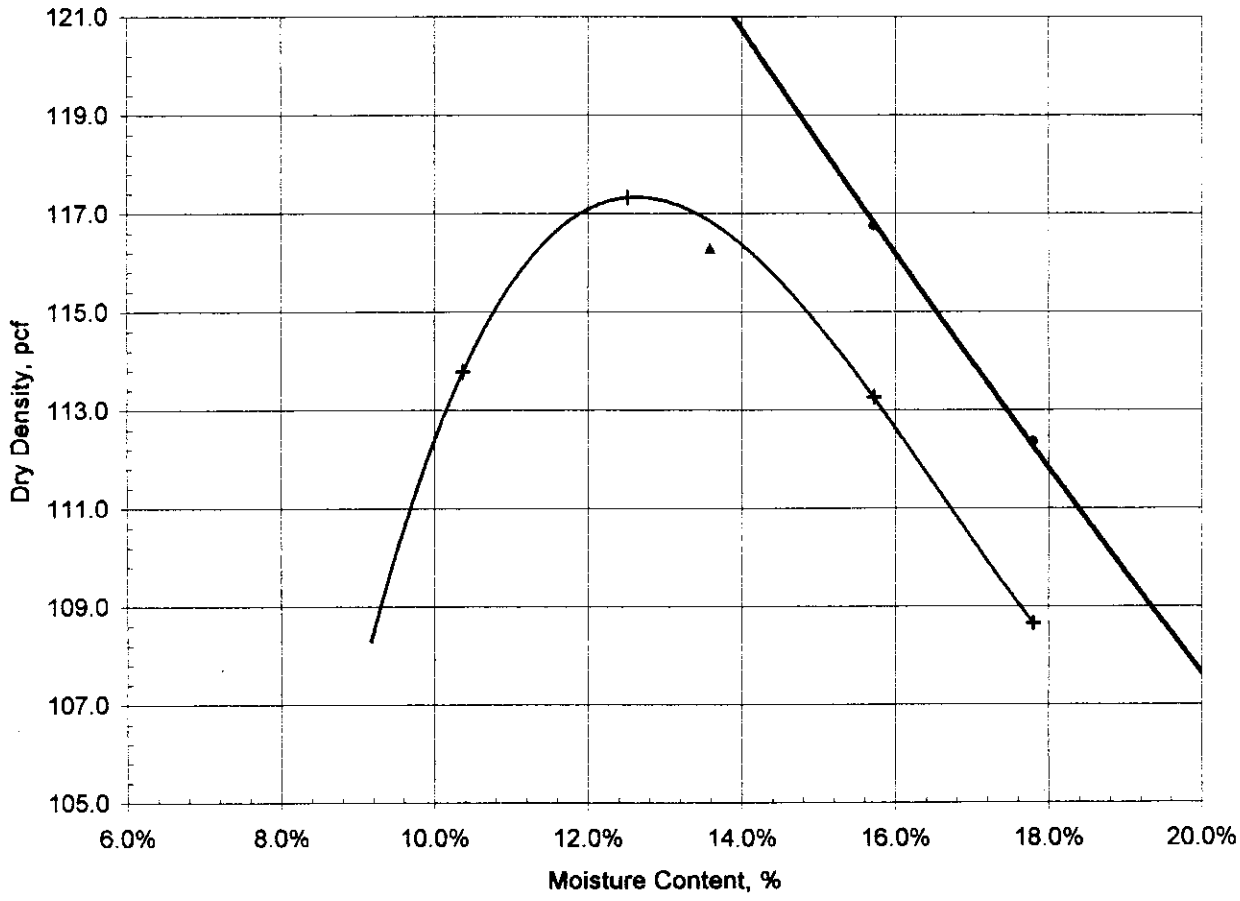
Soil and Test Method Data

Sample ID	L0-6
Sample Depth	2'-4'
Sample Classification	#DIV/0!
USCS Group Symbol	#DIV/0!
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	10.4%	12.5%	15.7%	17.8%	
Dry Density, pcf	113.8	117.3	113.3	108.6	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

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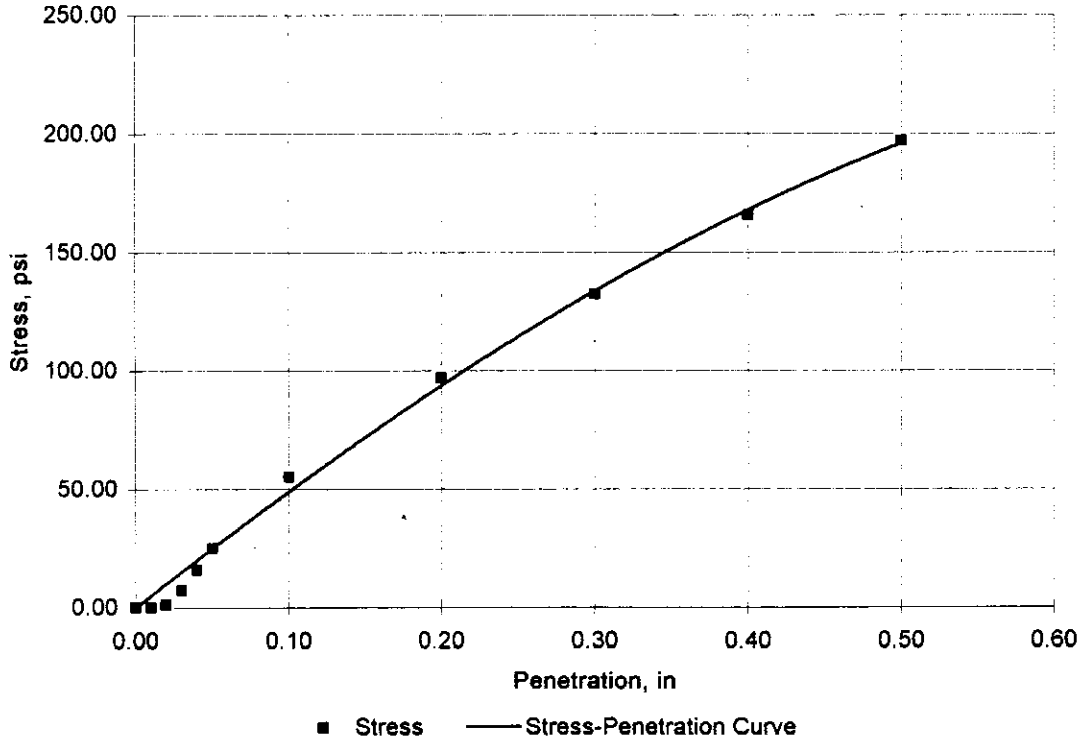
Soil and Test Method Data

Sample ID	L0-6
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	13.6%
Compacted Dry Density	116.3
Percent Compaction	99%
Percent Swell	0.4%
CBR @ 0.1"	5.5
CBR @ 0.2"	6.5



Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

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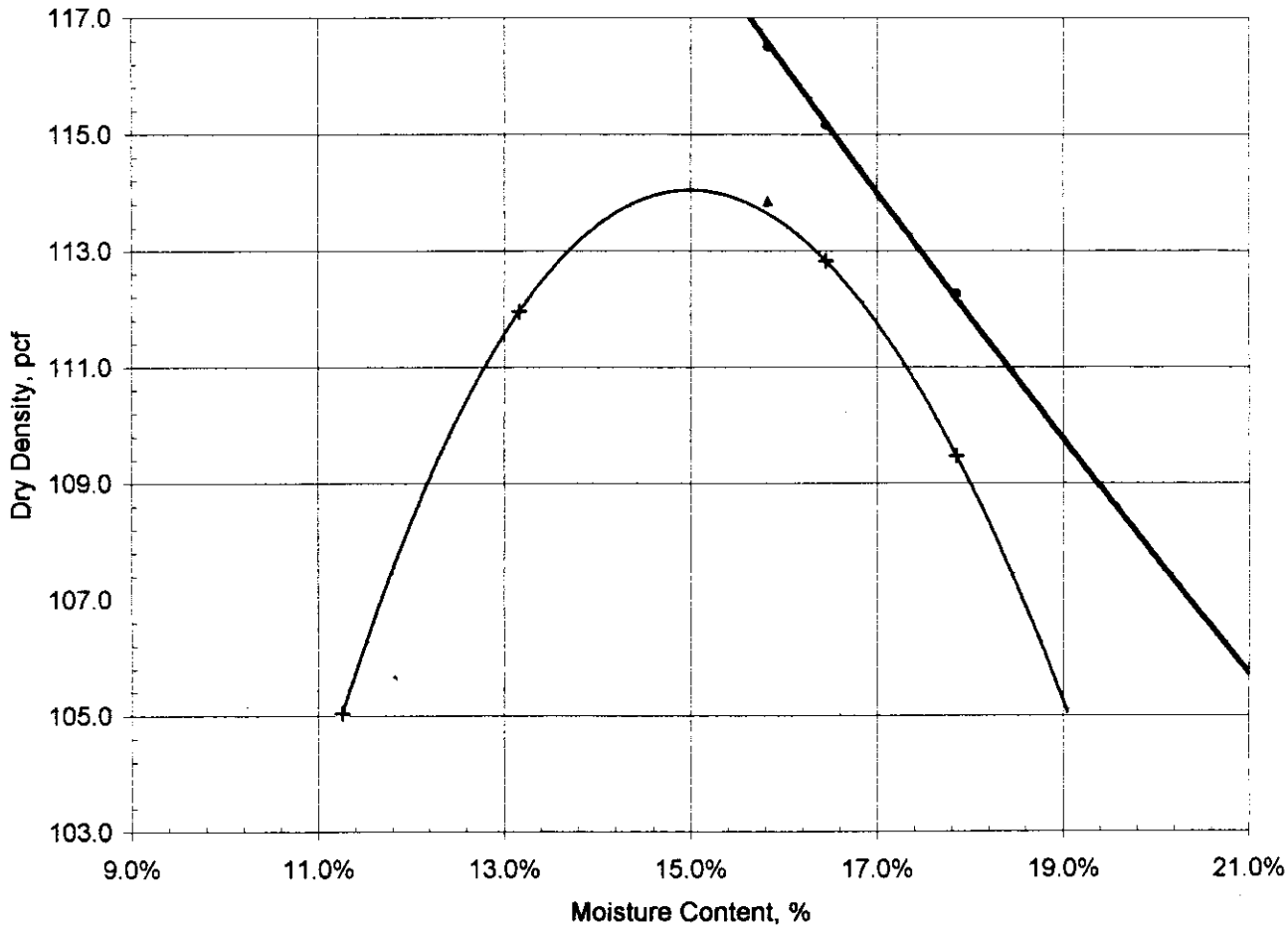
Soil and Test Method Data

Sample ID	B0-1
Sample Depth	2'-4'
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	11.3%	13.2%	16.4%	17.8%	
Dry Density, pcf	105.1	112.0	112.8	109.5	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

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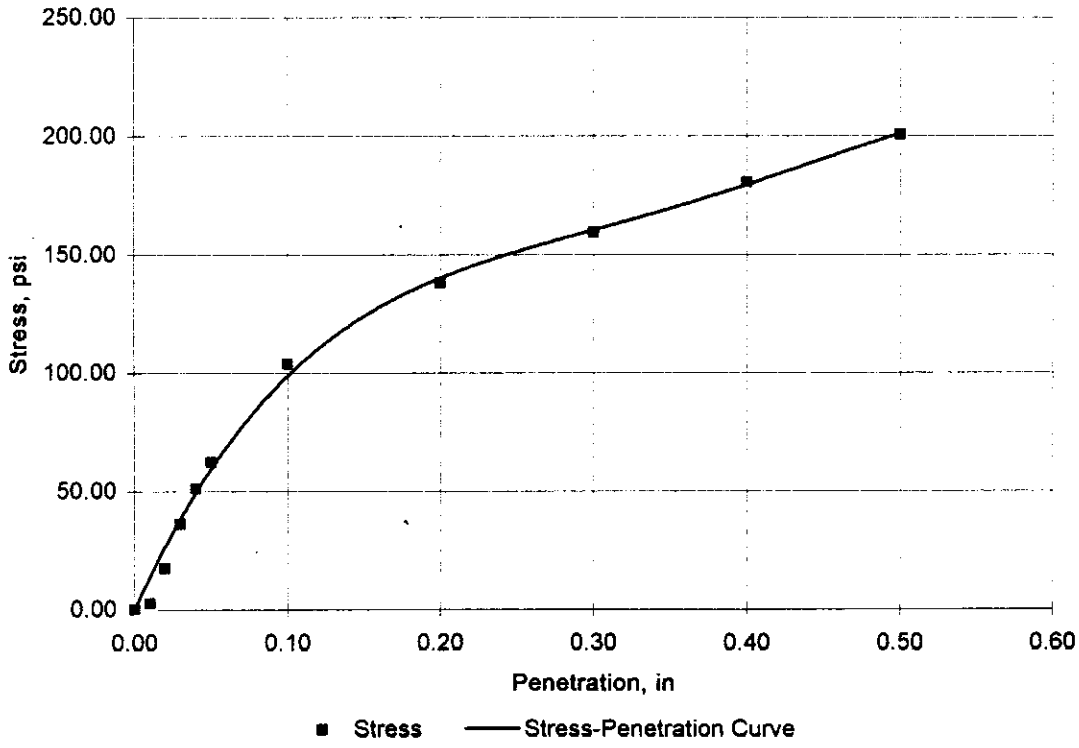
Soil and Test Method Data

Sample ID	B0-1
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	15.8%
Compacted Dry Density	113.9
Percent Compaction	100%
Percent Swell	0.3%
CBR @ 0.1"	10.4
CBR @ 0.2"	9.2



Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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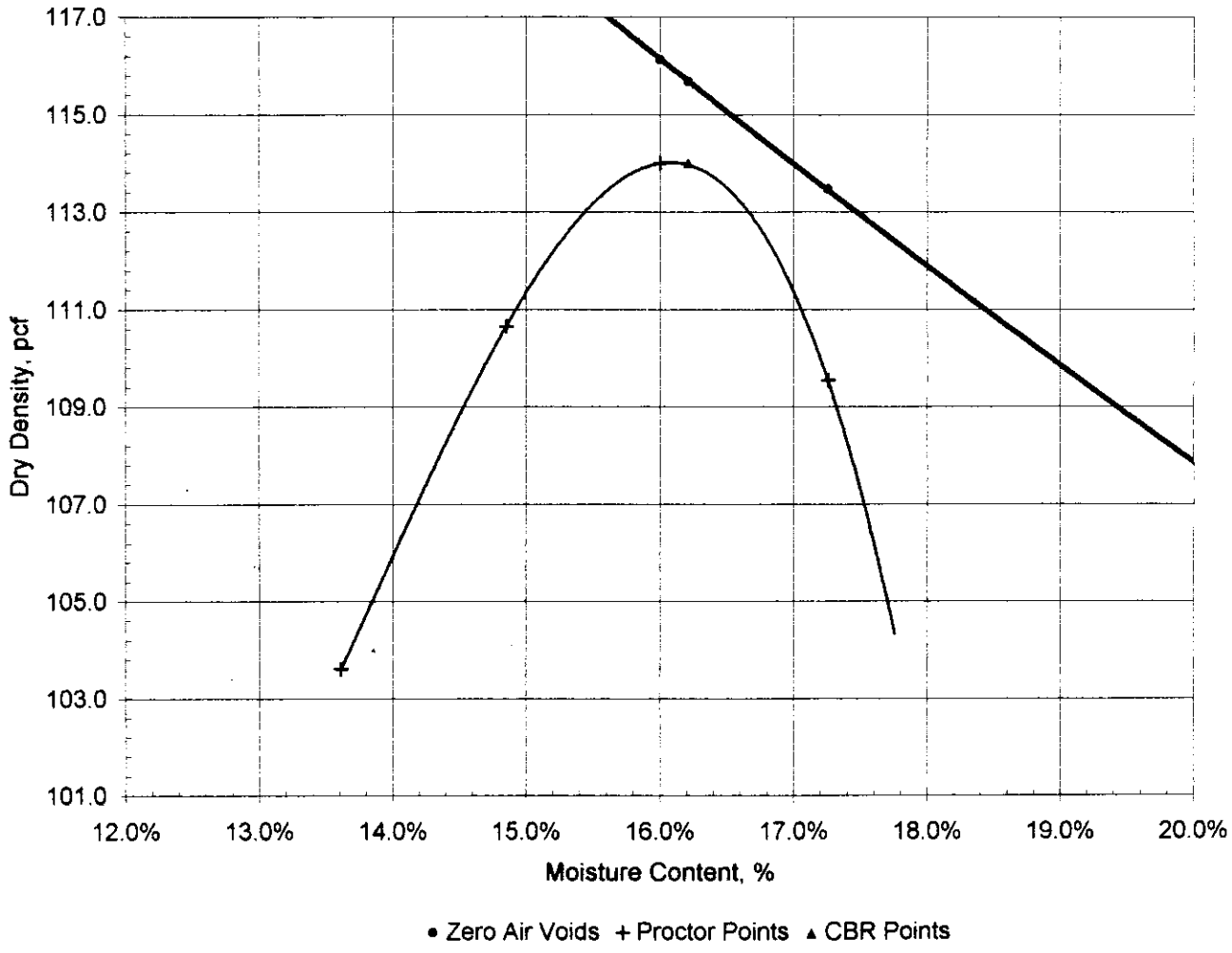
Soil and Test Method Data

Sample ID	B0-1A
Sample Depth	2'-4'
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	16.0%	13.6%	14.8%	17.3%	
Dry Density, pcf	114.0	103.6	110.7	109.5	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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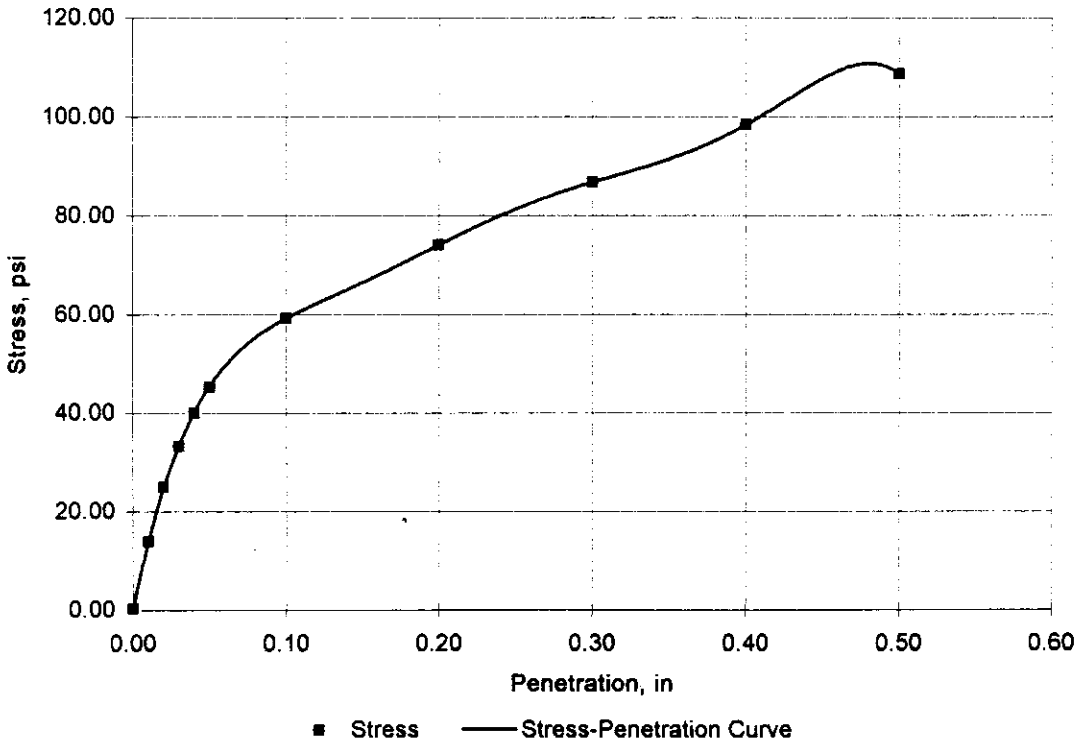
Soil and Test Method Data

Sample ID	B0-1A
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	16.2%
Compacted Dry Density	114.0
Percent Compaction	100%
Percent Swell	0.5%
CBR @ 0.1"	5.9
CBR @ 0.2"	4.9



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID B0-2
Sample Depth 0-2'

Natural Moisture Content

Pan ID	6
Pan Wt	194.72 grams
Pan + Soil (wet)	358.87 grams
Pan + Soil (dry)	334.46 grams
Natural Moisture Content	*17.5%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID B0-2
Sample Depth 2'-4'
Visual Sample Description Brown Clayey SAND

Natural Moisture Content

Pan ID	28	
Pan Wt	193.21	grams
Pan + Soil (wet)	290.44	grams
Pan + Soil (dry)	276.67	grams
Natural Moisture Content	*16.5%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	236.03	grams
Percent Passing No. 200 Sieve	48.7%	
Pan + Soil retained on No. 4 sieve (dry)	197.92	grams
Percent Passing No. 4 Sieve	94.4%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows	21	25	34
Pan ID	62	63	65
Pan Wt	10.89	10.73	10.99
Pan + Soil (wet)	24.45	18.17	20.01
Pan + Soil (dry)	20.60	16.11	17.65
Moisture Content	40%	38%	35%
Liquid Limit	39	38	37
Liquid Limit	*38*		

Plastic Limit

Pan ID	K	18
Pan Weight	2.36	2.39
Pan + Soil (wet)	9.45	7.93
Pan + Soil (dry)	8.46	7.17
Moisture Content	16%	16%
Plastic Limit	*16*	
Plastic Index	*22*	

USCS Classification

Group Symbol	SC
Group Name	Clayey SAND

Grain Size Distribution Calculations

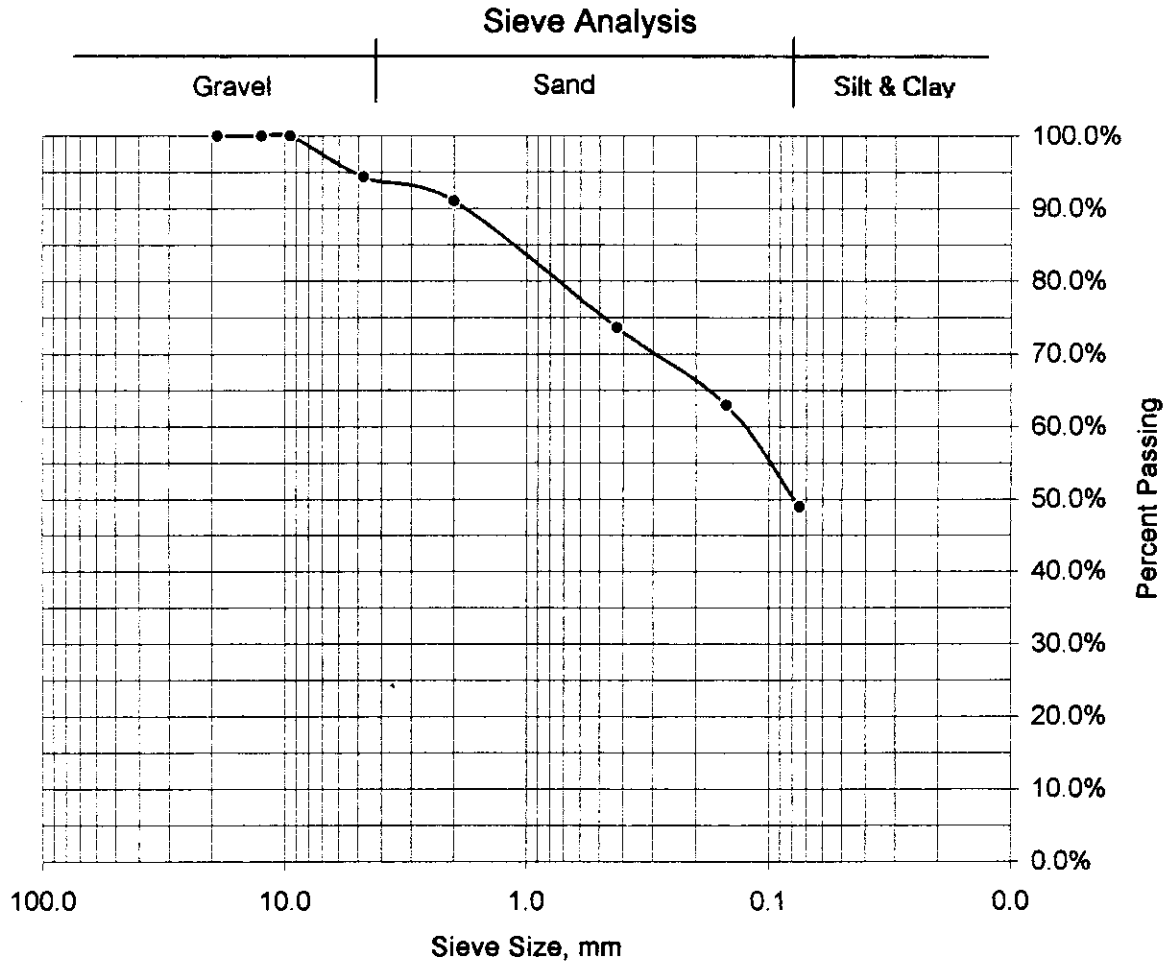
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID B0-2
Sample Depth 2'-4'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	4.71	5.6%	4.75	94.4%
No. 10	2.81	3.4%	2.0	91.0%
No. 40	14.51	17.4%	0.425	73.6%
No. 100	8.93	10.7%	0.15	62.9%
No. 200	11.68	14.0%	0.075	48.9%
Pan	0.18	0.2%		
Total	42.82	51.1%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID B0-2
Sample Depth 4'-6'

Natural Moisture Content

Pan ID	33
Pan Wt	193.70 grams
Pan + Soil (wet)	355.14 grams
Pan + Soil (dry)	326.87 grams
Natural Moisture Content	*21.2%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID B0-2
Sample Depth 6'-8'

Natural Moisture Content

Pan ID	16	
Pan Wt	189.42	grams
Pan + Soil (wet)	322.18	grams
Pan + Soil (dry)	290.55	grams
Natural Moisture Content	*31.3%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	BO-2
Sample Depth	8'-10'
Visual Sample Description	Brown Clayey SAND

Natural Moisture Content

Pan ID	16	
Pan Wt	189.43	grams
Pan + Soil (wet)	360.08	grams
Pan + Soil (dry)	320.92	grams
Natural Moisture Content	*29.8%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	295.27	grams
Percent Passing No. 200 Sieve	19.5%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID B0-2
Sample Depth 13'-15'

Natural Moisture Content

Pan ID	32
Pan Wt	191.68 grams
Pan + Soil (wet)	359.11 grams
Pan + Soil (dry)	318.68 grams
Natural Moisture Content	*31.8%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID B0-2
Sample Depth 18'-20'

Natural Moisture Content

Pan ID	13
Pan Wt	187.40 grams
Pan + Soil (wet)	324.89 grams
Pan + Soil (dry)	290.82 grams
Natural Moisture Content	*32.9%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID B0-2
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	17	
Pan Wt	188.65	grams
Pan + Soil (wet)	340.05	grams
Pan + Soil (dry)	302.72	grams
Natural Moisture Content	*32.7%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID B0-2
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	35
Pan Wt	192.74 grams
Pan + Soil (wet)	330.38 grams
Pan + Soil (dry)	297.30 grams
Natural Moisture Content	*31.6%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	BO-3
Sample Depth	6'-8'
Visual Sample Description	Brown Gravelly SAND

Natural Moisture Content

Pan ID	40	
Pan Wt	192.66	grams
Pan + Soil (wet)	339.03	grams
Pan + Soil (dry)	305.15	grams
Natural Moisture Content	*30.1%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	283.67	grams
Percent Passing No. 200 Sieve	19.1%	
Pan + Soil retained on No. 4 sieve (dry)	216.13	grams
Percent Passing No. 4 Sieve	79.1%	
Soil Classifies as	*Coarse-Grained Soil*	

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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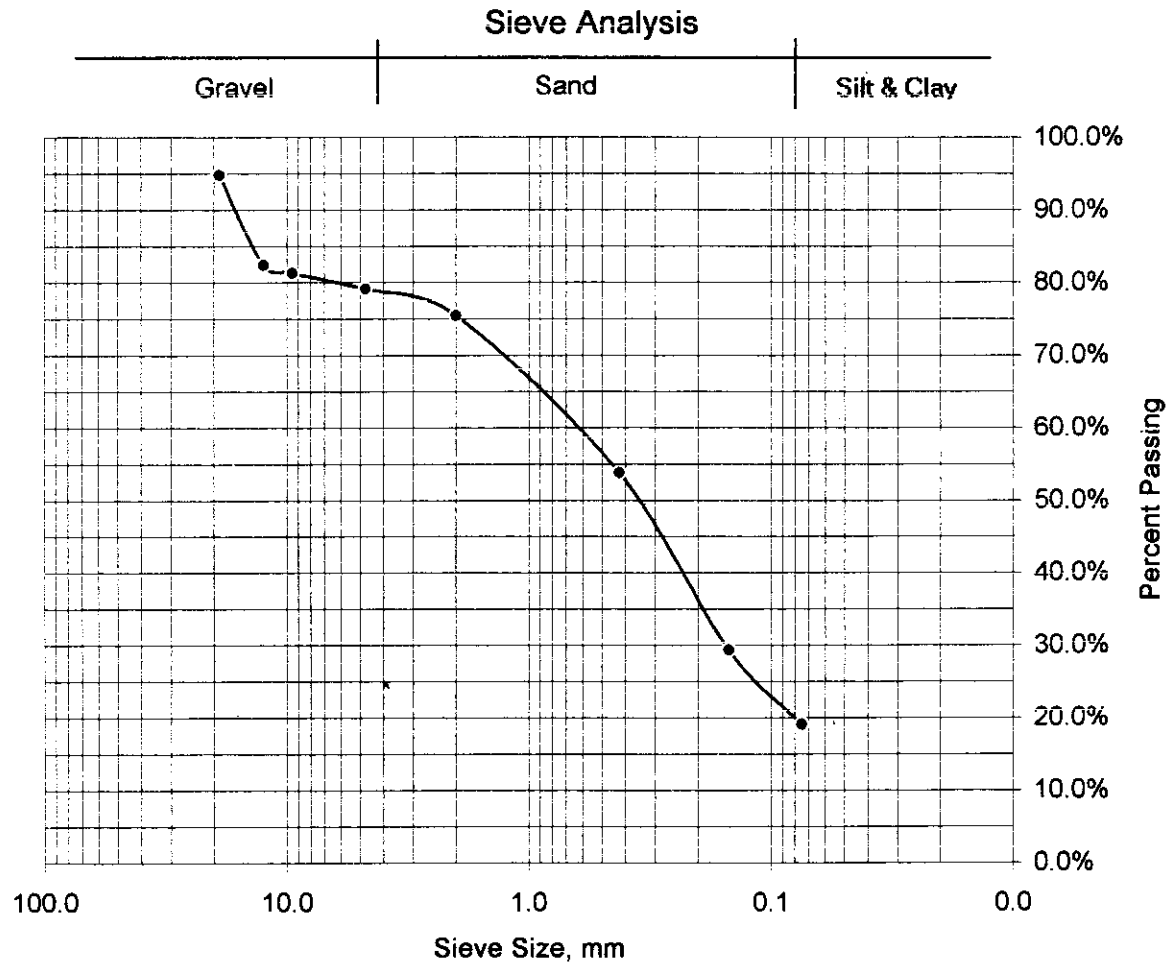
Sample ID BO-3
Sample Depth 6'-8'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	5.87	5.2%	19.0	94.8%
1/2"	13.90	12.4%	12.5	82.4%
3/8"	1.28	1.1%	9.5	81.3%
No. 4	2.42	2.2%	4.75	79.1%
No. 10	4.16	3.7%	2.0	75.4%
No. 40	24.37	21.7%	0.425	53.8%
No. 100	27.46	24.4%	0.15	29.4%
No. 200	11.51	10.2%	0.075	19.1%
Pan	0.38	0.3%		
Total	91.35	80.9%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	BO-3
Sample Depth	13'-15'
Visual Sample Description	Brown SAND

Natural Moisture Content

Pan ID	41	
Pan Wt	194.51	grams
Pan + Soil (wet)	324.33	grams
Pan + Soil (dry)	292.69	grams
Natural Moisture Content	*32.2%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	278.90	grams
Percent Passing No. 200 Sieve	14.0%	

Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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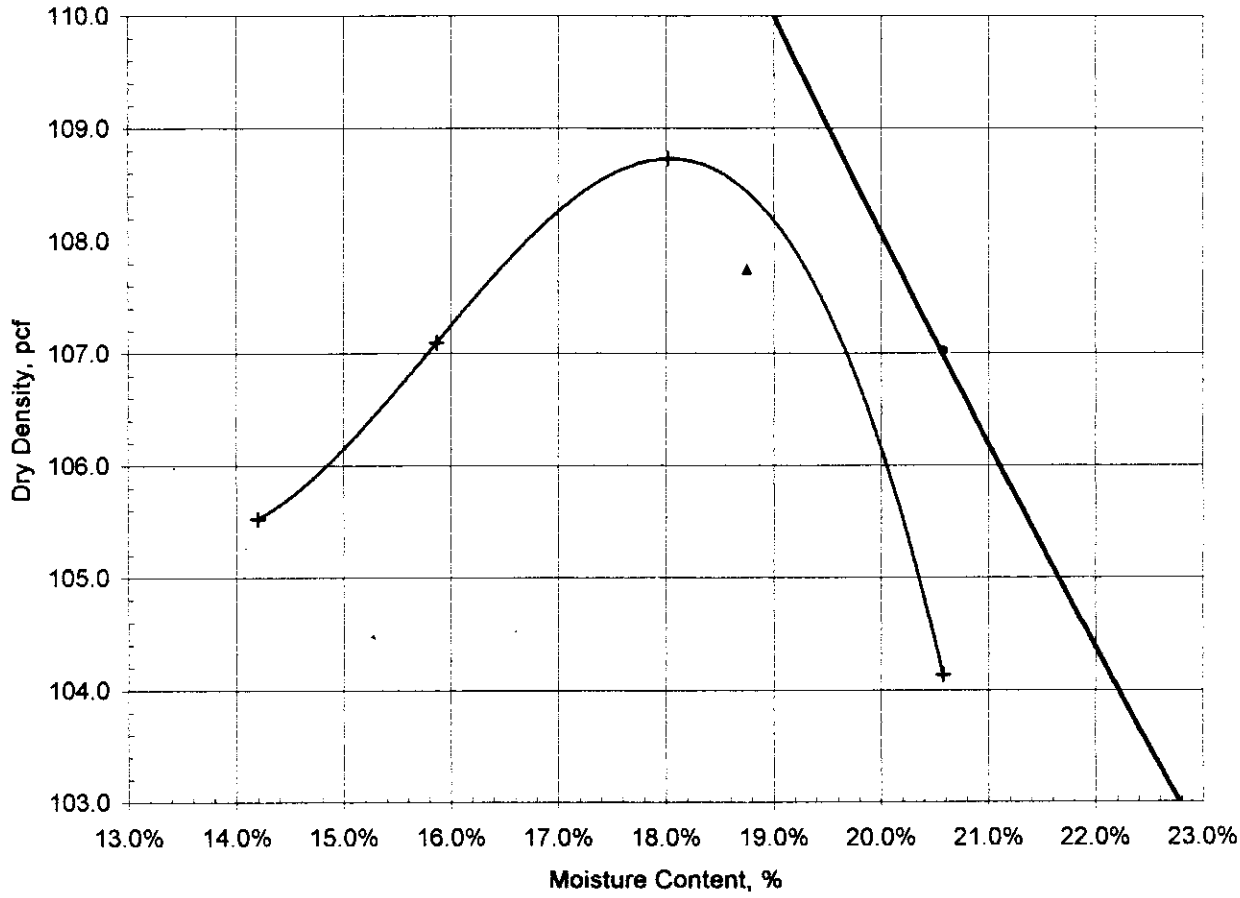
Soil and Test Method Data

Sample ID	B0-5
Sample Depth	2'-4'
Sample Classification	#DIV/0!
USCS Group Symbol	#DIV/0!
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	14.2%	15.9%	18.0%	20.6%	
Dry Density, pcf	105.5	107.1	108.7	104.1	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

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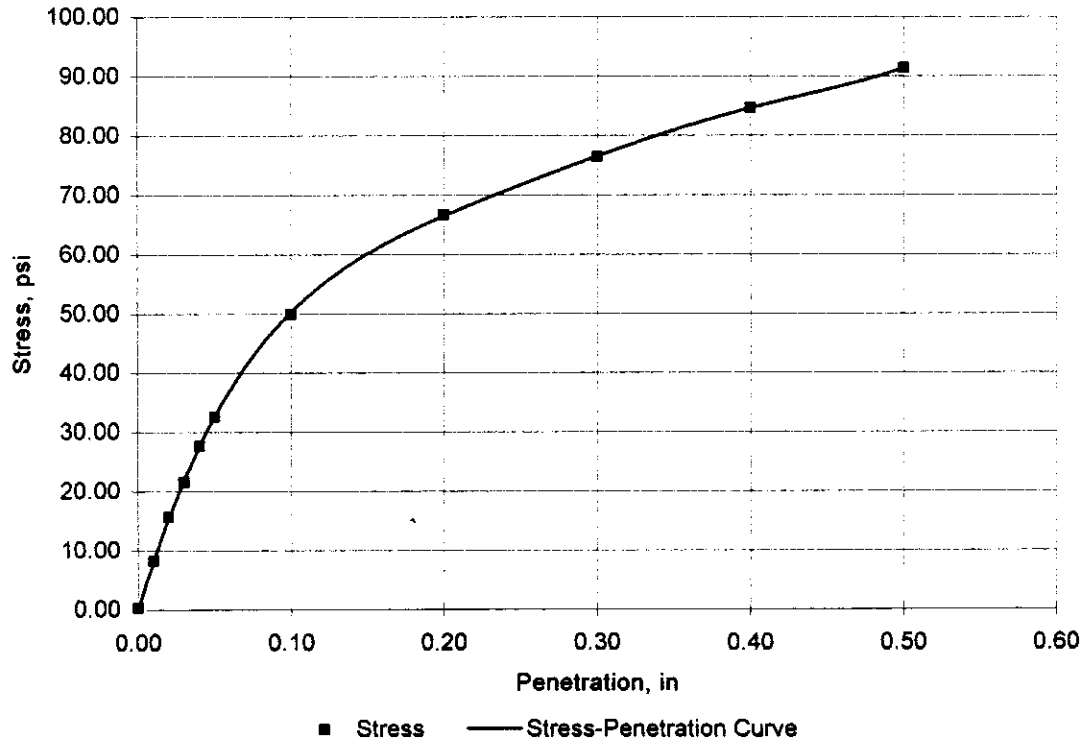
Soil and Test Method Data

Sample ID	B0-5
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	18.8%
Compacted Dry Density	107.8
Percent Compaction	99%
Percent Swell	0.4%
CBR @ 0.1"	5.0
CBR @ 0.2"	4.4



Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

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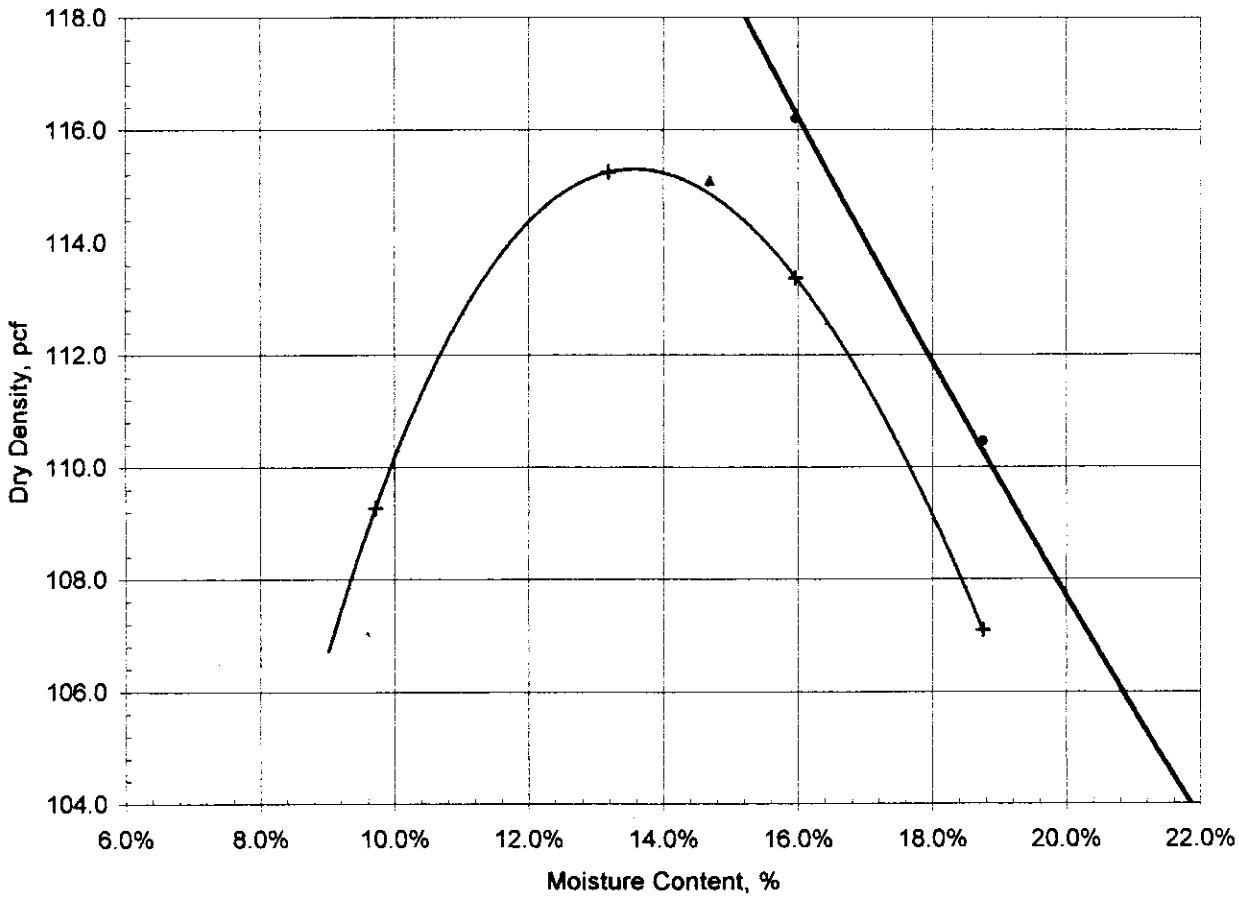
Soil and Test Method Data

Sample ID	B0-6
Sample Depth	2'-4'
Sample Classification	#DIV/0!
USCS Group Symbol	#DIV/0!
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	9.7%	13.2%	16.0%	18.8%	
Dry Density, pcf	109.3	115.3	113.4	107.1	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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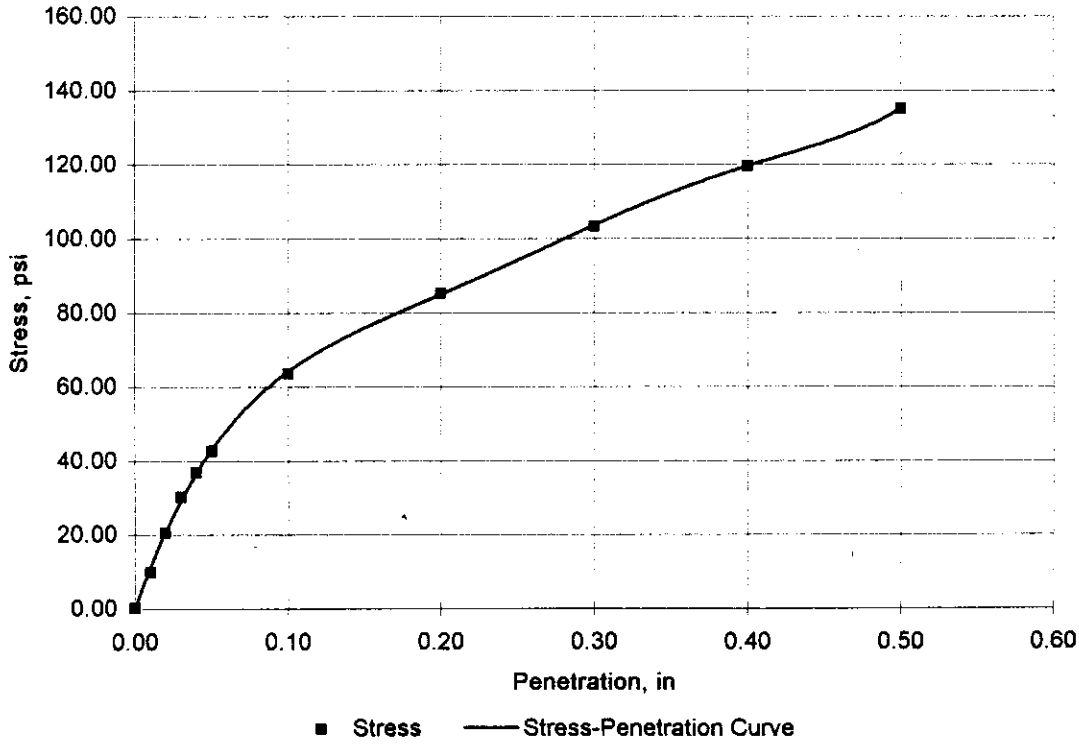
Soil and Test Method Data

Sample ID	B0-6
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	14.7%
Compacted Dry Density	115.1
Percent Compaction	100%
Percent Swell	0.4%
CBR @ 0.1"	6.4
CBR @ 0.2"	5.7



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	AMU-1
Sample Depth	8-10'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	32
Pan Wt	191.74 grams
Pan + Soil (wet)	365.27 grams
Pan + Soil (dry)	319.90 grams
Natural Moisture Content	*35.4%*

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	292.01 grams
Percent Passing No. 200 Sieve	21.8%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	AMU-1
Sample Depth	18-20'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	A106	
Pan Wt	8.21	grams
Pan + Soil (wet)	141.42	grams
Pan + Soil (dry)	107.03	grams
Natural Moisture Content	*34.8%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	92.11	grams
Percent Passing No. 200 Sieve	15.1%	
Pan + Soil retained on No. 4 sieve (dry)	8.21	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Coarse-Grained Soil*	

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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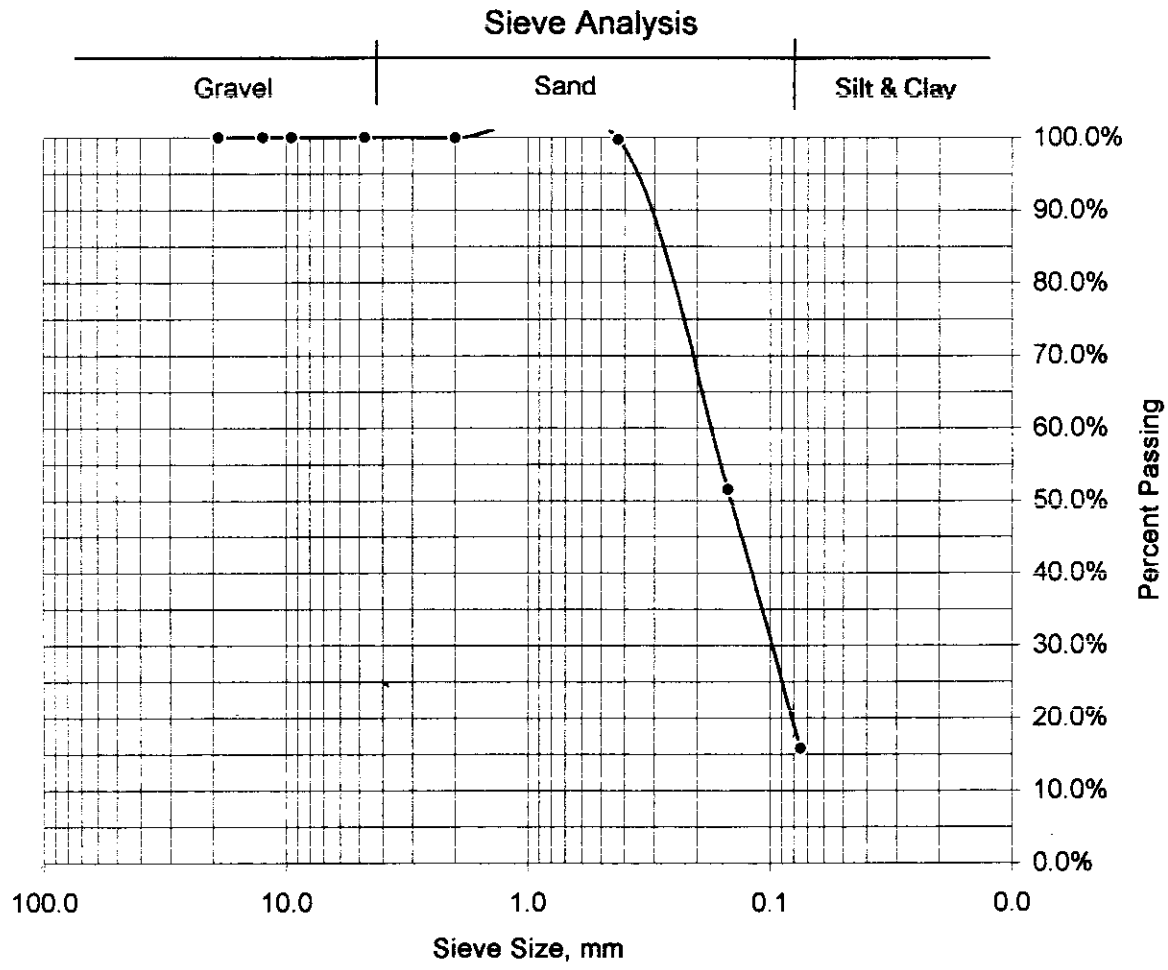
Sample ID AMU-1
Sample Depth 18-20'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	0.05	0.1%	2.0	99.9%
No. 40	0.23	0.2%	0.425	99.7%
No. 100	47.62	48.2%	0.15	51.5%
No. 200	35.32	35.7%	0.075	15.8%
Pan	0.60	0.6%		
Total	83.82	84.2%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

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Sample ID AMU-2
Sample Depth 0-2'

Natural Moisture Content

Pan ID	7	
Pan Wt	192.35	grams
Pan + Soil (wet)	397.33	grams
Pan + Soil (dry)	380.00	grams
Natural Moisture Content	*9.2%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

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Sample ID AMU-2
Sample Depth 2'-4'

Natural Moisture Content

Pan ID	23	
Pan Wt	194.03	grams
Pan + Soil (wet)	391.15	grams
Pan + Soil (dry)	354.33	grams
Natural Moisture Content	*23.0%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID AMU-2
Sample Depth 4'-6'
Visual Sample Description Gray Clayey SAND

Natural Moisture Content

Pan ID	18	
Pan Wt	189.10	grams
Pan + Soil (wet)	304.16	grams
Pan + Soil (dry)	284.95	grams
Natural Moisture Content	*20.0%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	253.60	grams
Percent Passing No. 200 Sieve	32.7%	
Pan + Soil retained on No. 4 sieve (dry)	192.43	grams
Percent Passing No. 4 Sieve	96.5%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows	18	28	34
Pan ID	70	69	72
Pan Wt	10.89	10.92	11.04
Pan + Soil (wet)	18.85	20.03	21.6
Pan + Soil (dry)	16.24	17.14	18.39
Moisture Content	49%	46%	44%
Liquid Limit	47	47	45
Liquid Limit	*47*		

Plastic Limit

Pan ID	25	H
Pan Weight	2.38	2.41
Pan + Soil (wet)	11.18	12.78
Pan + Soil (dry)	9.89	11.26
Moisture Content	17%	17%
Plastic Limit	*17*	
Plastic Index	*29*	

USCS Classification

Group Symbol	SC
Group Name	Clayey SAND

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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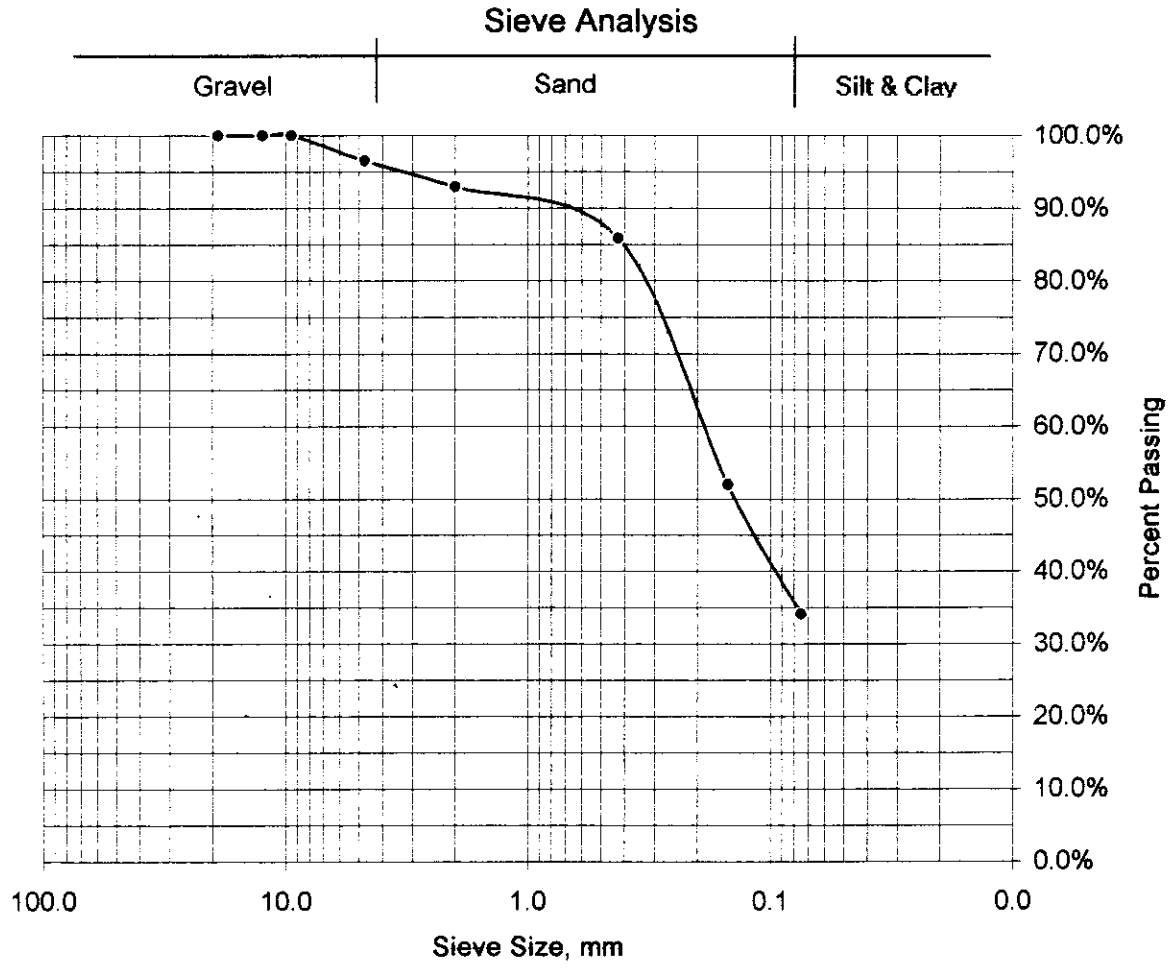
Sample ID AMU-2
Sample Depth 4'-6'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	3.33	3.5%	4.75	96.5%
No. 10	3.45	3.6%	2.0	92.9%
No. 40	6.73	7.0%	0.425	85.9%
No. 100	32.58	34.0%	0.15	51.9%
No. 200	17.03	17.8%	0.075	34.1%
Pan	0.22	0.2%		
Total	63.34	65.9%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 6'-8'

Natural Moisture Content

Pan ID	21	
Pan Wt	198.41	grams
Pan + Soil (wet)	354.93	grams
Pan + Soil (dry)	316.55	grams
Natural Moisture Content	*32.5%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 8'-10'

Natural Moisture Content

Pan ID	20
Pan Wt	190.29 grams
Pan + Soil (wet)	332.11 grams
Pan + Soil (dry)	296.01 grams
Natural Moisture Content	*34.1%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 13'-15'

Natural Moisture Content

Pan ID	40	
Pan Wt	192.72	grams
Pan + Soil (wet)	325.00	grams
Pan + Soil (dry)	290.67	grams
Natural Moisture Content	*35.0%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	AMU-2
Sample Depth	18'-20'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	20	
Pan Wt	189.95	grams
Pan + Soil (wet)	310.90	grams
Pan + Soil (dry)	278.24	grams
Natural Moisture Content	*37.0%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	263.43	grams
Percent Passing No. 200 Sieve	16.8%	
Pan + Soil retained on No. 4 sieve (dry)	189.95	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows			
Pan ID			
Pan Wt	Non-Plastic		
Pan + Soil (wet)			
Pan + Soil (dry)			
Moisture Content	0%	0%	0%
Liquid Limit	0	NA	NA
Liquid Limit	*0*		

Plastic Limit

Pan ID		
Pan Weight	Non-Plastic	
Pan + Soil (wet)		
Pan + Soil (dry)		
Moisture Content	0%	0%
Plastic Limit	*0*	
Plastic Index	*0*	

USCS Classification

Group Symbol	SM
Group Name	Silty SAND

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	39
Pan Wt	192.99 grams
Pan + Soil (wet)	312.17 grams
Pan + Soil (dry)	282.70 grams
Natural Moisture Content	*32.9%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	15	
Pan Wt	188.51	grams
Pan + Soil (wet)	326.51	grams
Pan + Soil (dry)	291.02	grams
Natural Moisture Content	*34.6%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-2
Sample Depth 33'-35'

Natural Moisture Content

Pan ID	41
Pan Wt	196.43 grams
Pan + Soil (wet)	331.90 grams
Pan + Soil (dry)	297.50 grams
Natural Moisture Content	*34.0%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	AMU-2
Sample Depth	38'-40'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	3	
Pan Wt	193.07	grams
Pan + Soil (wet)	308.90	grams
Pan + Soil (dry)	279.88	grams
Natural Moisture Content	*33.4%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	260.38	grams
Percent Passing No. 200 Sieve	22.5%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 43'-45'

Natural Moisture Content

Pan ID	2
Pan Wt	196.25 grams
Pan + Soil (wet)	333.60 grams
Pan + Soil (dry)	299.64 grams
Natural Moisture Content	*32.8%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 48'-50'

Natural Moisture Content

Pan ID	1
Pan Wt	195.44 grams
Pan + Soil (wet)	309.10 grams
Pan + Soil (dry)	280.02 grams
Natural Moisture Content	*34.4%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 53'-55'

Natural Moisture Content

Pan ID	26
Pan Wt	194.56 grams
Pan + Soil (wet)	304.33 grams
Pan + Soil (dry)	275.31 grams
Natural Moisture Content	*35.9%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-2
Sample Depth 58'-60'

Natural Moisture Content

Pan ID	18	
Pan Wt	189.61	grams
Pan + Soil (wet)	317.78	grams
Pan + Soil (dry)	283.76	grams
Natural Moisture Content	*36.1%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	AMU-3
Sample Depth	2'-4'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	X5	
Pan Wt	8.32	grams
Pan + Soil (wet)	159.22	grams
Pan + Soil (dry)	138.50	grams
Natural Moisture Content	*15.9%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	91.39	grams
Percent Passing No. 200 Sieve	36.2%	
Pan + Soil retained on No. 4 sieve (dry)	15.12	grams
Percent Passing No. 4 Sieve	94.8%	
Soil Classifies as	*Coarse-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows	18	23	33
Pan ID	1	7	9
Pan Wt	11.22	11.12	11.12
Pan + Soil (wet)	20.74	22.81	25.32
Pan + Soil (dry)	18.49	20.12	22.1
Moisture Content	31%	30%	29%
Liquid Limit	30	30	30
Liquid Limit	*30*		

Plastic Limit

Pan ID	32	52
Pan Weight	2.38	2.37
Pan + Soil (wet)	6.23	4.87
Pan + Soil (dry)	5.70	4.55
Moisture Content	16%	15%
Plastic Limit	*15*	
Plastic Index	*14*	

USCS Classification

Group Symbol	SC
Group Name	Clayey SAND

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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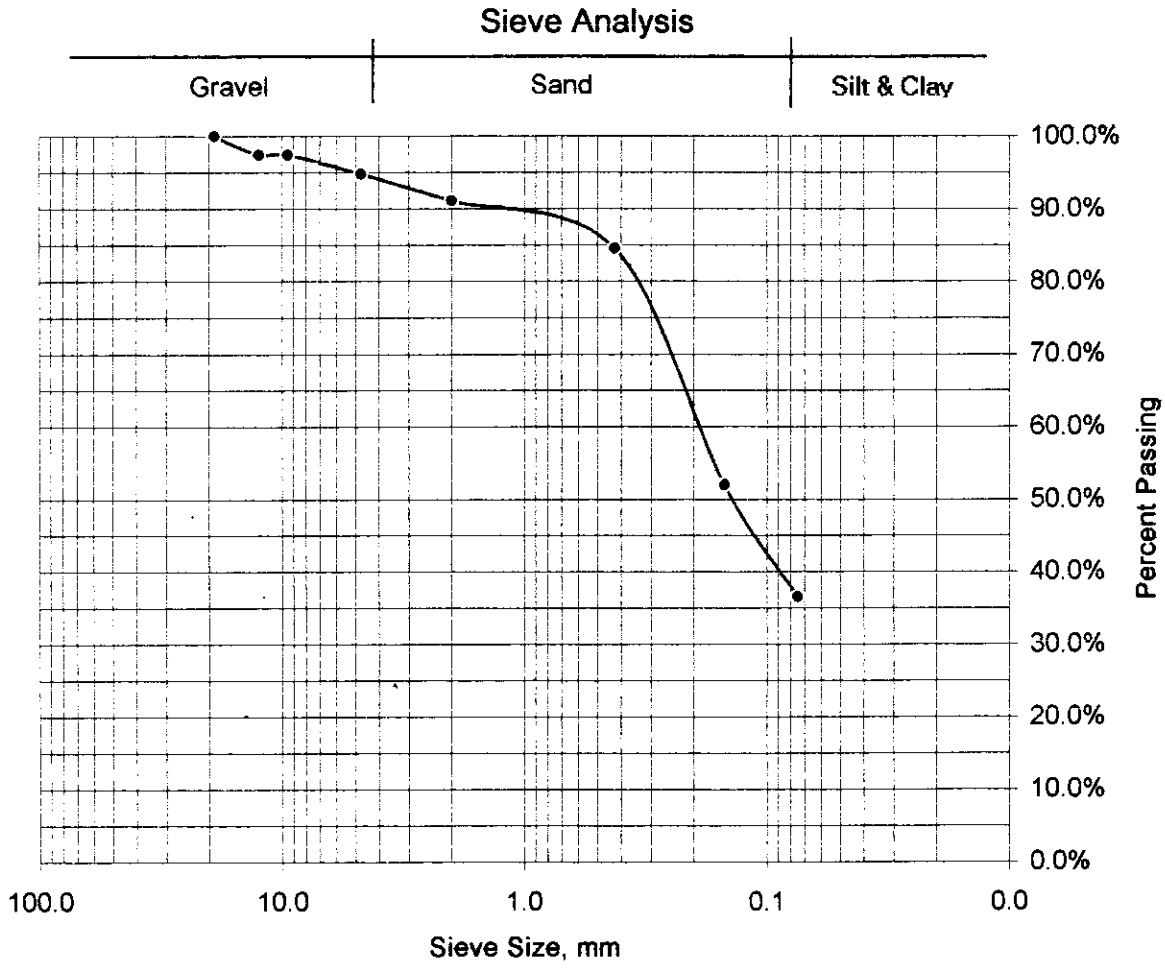
Sample ID AMU-3
Sample Depth 2'-4'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	3.37	2.6%	12.5	97.4%
3/8"	0.00	0.0%	9.5	97.4%
No. 4	3.43	2.6%	4.75	94.8%
No. 10	4.80	3.7%	2.0	91.1%
No. 40	8.47	6.5%	0.425	84.6%
No. 100	42.50	32.6%	0.15	51.9%
No. 200	20.01	15.4%	0.075	36.6%
Pan	0.32	0.2%		
Total	82.90	63.4%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	AMU-3
Sample Depth	6'8'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	A109	
Pan Wt	8.21	grams
Pan + Soil (wet)	143.83	grams
Pan + Soil (dry)	107.87	grams
Natural Moisture Content	*36.1%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	88.71	grams
Percent Passing No. 200 Sieve	19.2%	
Pan + Soil retained on No. 4 sieve (dry)	8.21	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Coarse-Grained Soil*	

Grain Size Distribution Calculations

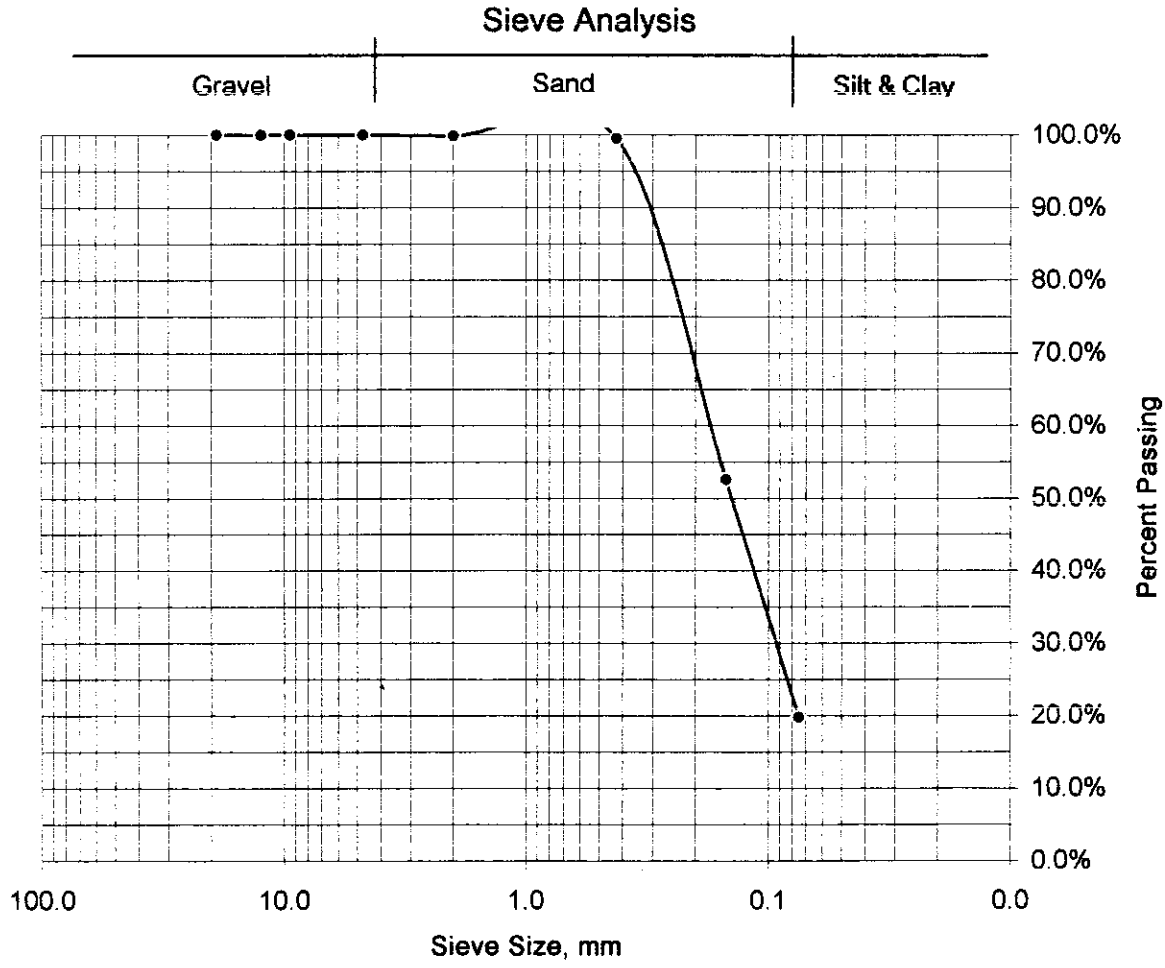
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-3
Sample Depth 6'8'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	0.17	0.2%	2.0	99.8%
No. 40	0.34	0.3%	0.425	99.5%
No. 100	46.80	47.0%	0.15	52.5%
No. 200	32.60	32.7%	0.075	19.8%
Pan	0.22	0.2%		
Total	80.13	80.2%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-5
Sample Depth 4-6'
Visual Sample Description Gray Clayey SAND

Natural Moisture Content

Pan ID	17	
Pan Wt	188.66	grams
Pan + Soil (wet)	290.60	grams
Pan + Soil (dry)	264.68	grams
Natural Moisture Content	*34.1%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	246.80	grams
Percent Passing No. 200 Sieve	23.5%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	AMU-5
Sample Depth	13'-15'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	36
Pan Wt	193.68 grams
Pan + Soil (wet)	301.90 grams
Pan + Soil (dry)	273.19 grams
Natural Moisture Content	*36.1%*

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	261.36 grams
Percent Passing No. 200 Sieve	14.9%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
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Sample ID	AMU-6
Sample Depth	2'-4'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	20
Pan Wt	190.04 grams
Pan + Soil (wet)	369.09 grams
Pan + Soil (dry)	350.02 grams
Natural Moisture Content	*11.9%*

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	318.36 grams
Percent Passing No. 200 Sieve	19.8%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	AMU-6
Sample Depth	8'-10'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	6	
Pan Wt	195.36	grams
Pan + Soil (wet)	297.87	grams
Pan + Soil (dry)	272.30	grams
Natural Moisture Content	*33.2%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	258.22	grams
Percent Passing No. 200 Sieve	18.3%	
Pan + Soil retained on No. 4 sieve (dry)	195.36	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Coarse-Grained Soil*	

Grain Size Distribution Calculations

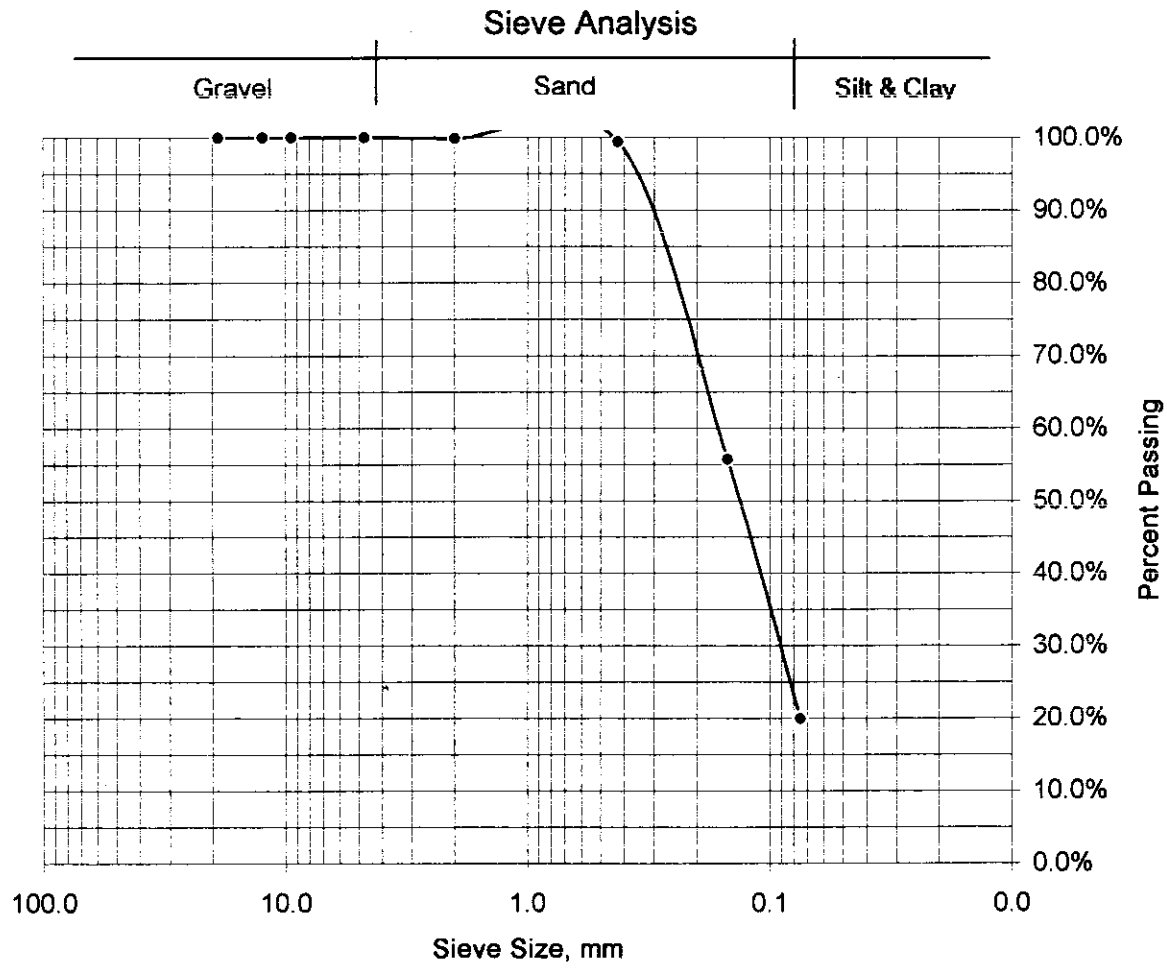
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-6
Sample Depth 8'-10'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	0.10	0.1%	2.0	99.9%
No. 40	0.35	0.5%	0.425	99.4%
No. 100	33.65	43.7%	0.15	55.7%
No. 200	27.48	35.7%	0.075	20.0%
Pan	0.46	0.6%		
Total	62.04	80.0%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-6
Sample Depth 4'-6'

Natural Moisture Content

Pan ID	38	
Pan Wt	193.57	grams
Pan + Soil (wet)	358.98	grams
Pan + Soil (dry)	327.12	grams
Natural Moisture Content	*23.9%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-6
Sample Depth 6'-8'

Natural Moisture Content

Pan ID	6
Pan Wt	193.79 grams
Pan + Soil (wet)	375.28 grams
Pan + Soil (dry)	334.57 grams
Natural Moisture Content	*28.9%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-6
Sample Depth 13'-15'

Natural Moisture Content

Pan ID	22
Pan Wt	189.02 grams
Pan + Soil (wet)	355.08 grams
Pan + Soil (dry)	313.87 grams
Natural Moisture Content	*33.0%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-6
Sample Depth 18'-20'

Natural Moisture Content

Pan ID	4	
Pan Wt	194.44	grams
Pan + Soil (wet)	337.91	grams
Pan + Soil (dry)	300.21	grams
Natural Moisture Content	*35.6%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-6
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	30
Pan Wt	193.54 grams
Pan + Soil (wet)	328.31 grams
Pan + Soil (dry)	294.55 grams
Natural Moisture Content	*33.4%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-6
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	10
Pan Wt	183.99 grams
Pan + Soil (wet)	288.57 grams
Pan + Soil (dry)	263.21 grams
Natural Moisture Content	*32.0%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-6
Sample Depth 33'-35'

Natural Moisture Content

Pan ID	42	
Pan Wt	192.21	grams
Pan + Soil (wet)	318.00	grams
Pan + Soil (dry)	287.82	grams
Natural Moisture Content	*31.6%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-6
Sample Depth 38'-40'

Natural Moisture Content

Pan ID	27	
Pan Wt	193.75	grams
Pan + Soil (wet)	336.24	grams
Pan + Soil (dry)	303.46	grams
Natural Moisture Content	*29.9%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-6
Sample Depth 43'-45'

Natural Moisture Content

Pan ID	A-106	
Pan Wt	8.33	grams
Pan + Soil (wet)	114.79	grams
Pan + Soil (dry)	85.85	grams
Natural Moisture Content	*37.3%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-6
Sample Depth 48'-50'

Natural Moisture Content

Pan ID	3
Pan Wt	192.10 grams
Pan + Soil (wet)	324.17 grams
Pan + Soil (dry)	288.14 grams
Natural Moisture Content	*37.5%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-6
Sample Depth 53'-55'

Natural Moisture Content

Pan ID	25	
Pan Wt	194.72	grams
Pan + Soil (wet)	383.29	grams
Pan + Soil (dry)	333.73	grams
Natural Moisture Content	*35.7%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-6
Sample Depth 58'-60'

Natural Moisture Content

Pan ID	24	
Pan Wt	189.63	grams
Pan + Soil (wet)	300.74	grams
Pan + Soil (dry)	269.54	grams
Natural Moisture Content	*39.0%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-6
Sample Depth 63'-65'

Natural Moisture Content

Pan ID	8
Pan Wt	187.32 grams
Pan + Soil (wet)	333.34 grams
Pan + Soil (dry)	295.00 grams
Natural Moisture Content	*35.6%*

Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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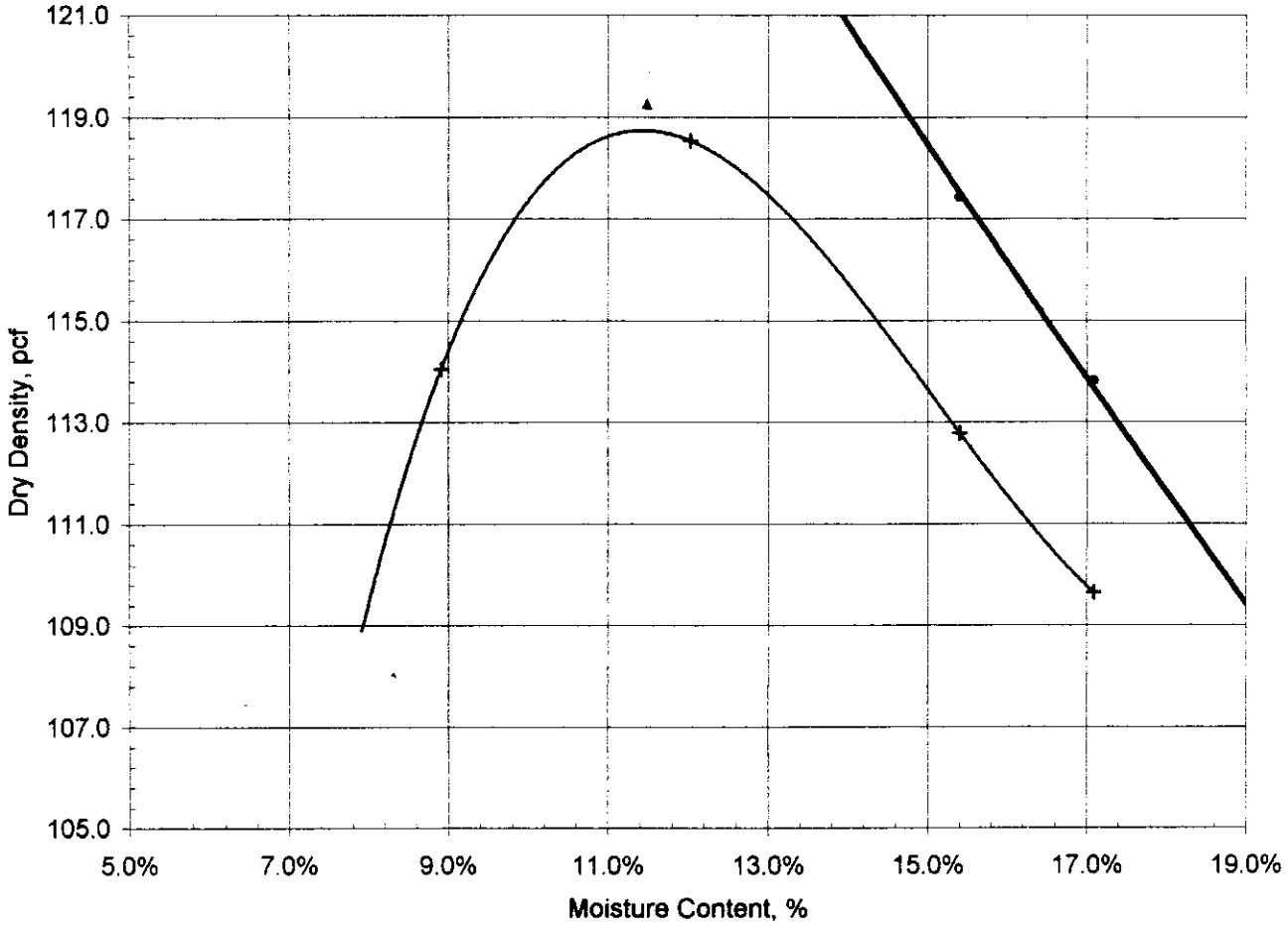
Soil and Test Method Data

Sample ID	AMU-7
Sample Depth	2'-4'
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	8.9%	12.0%	15.4%	17.1%	
Dry Density, pcf	114.0	118.5	112.8	109.6	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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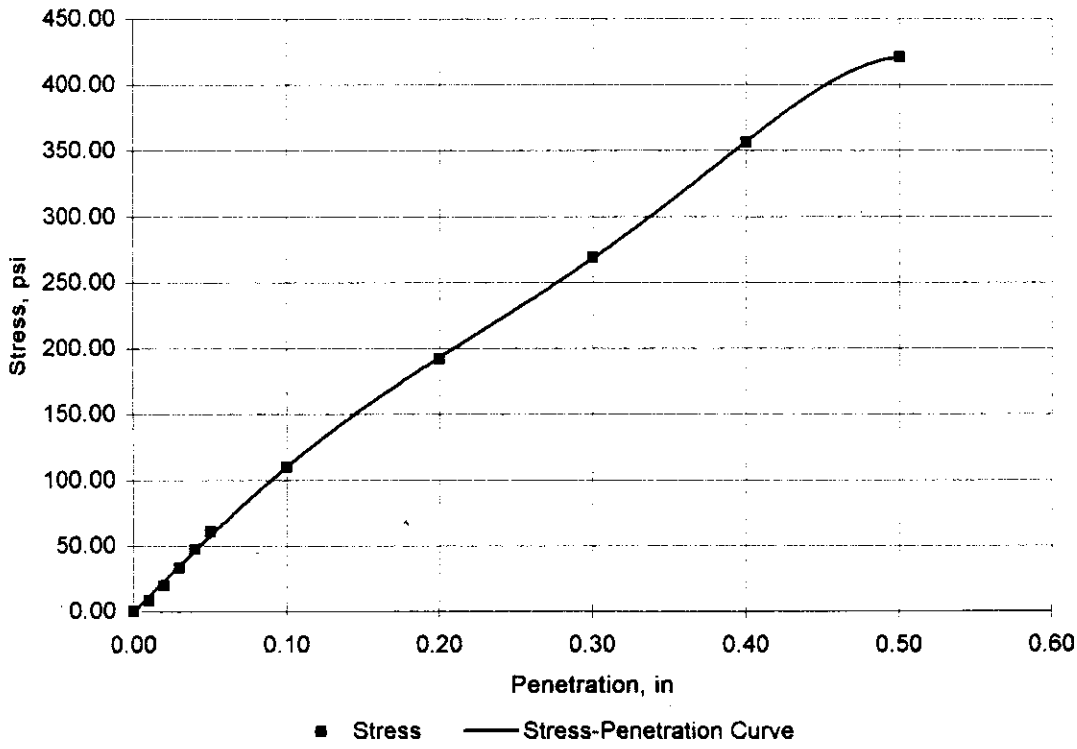
Soil and Test Method Data

Sample ID	AMU-7
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	11.5%
Compacted Dry Density	119.3
Percent Compaction	100%
Percent Swell	-0.3%
CBR @ 0.1"	11.0
CBR @ 0.2"	12.8



Proctor Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

Draper Aden Associates
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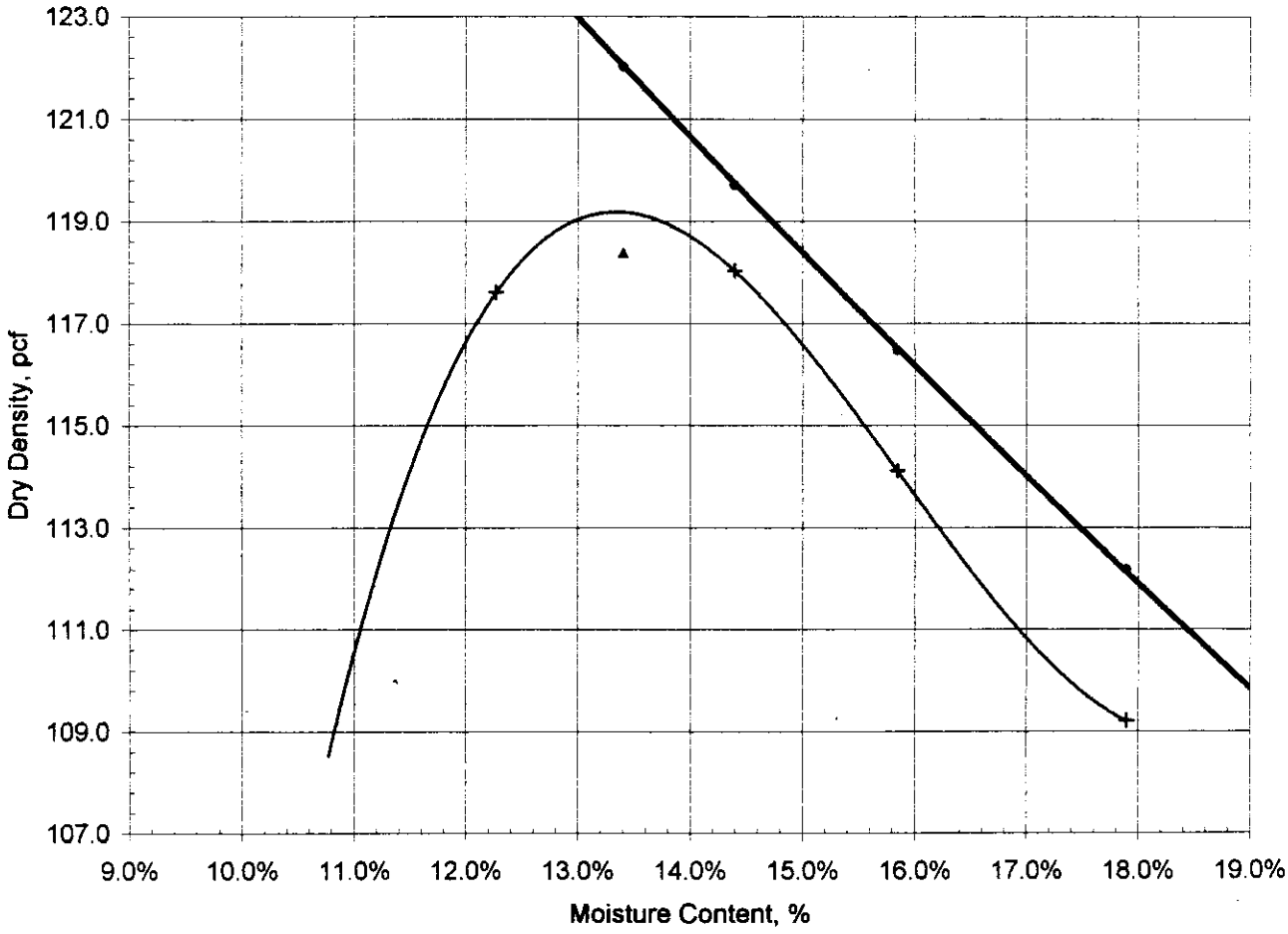
Soil and Test Method Data

Sample ID	AMU-8
Sample Depth	2'-4'
Test Method	ASTM D698, Method B, with mechanical hammer
Sample Preparation	Air dried and sieved through a 3/8" sieve.
Mold Size, in	4.0

Test Data	#1	#2	#3	#4	#5
Moisture Content	12.3%	14.4%	15.8%	17.9%	
Dry Density, pcf	117.6	118.0	114.1	109.2	

Moisture-Density Curve



• Zero Air Voids + Proctor Points ▲ CBR Points

CBR Test Report

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared by LTW

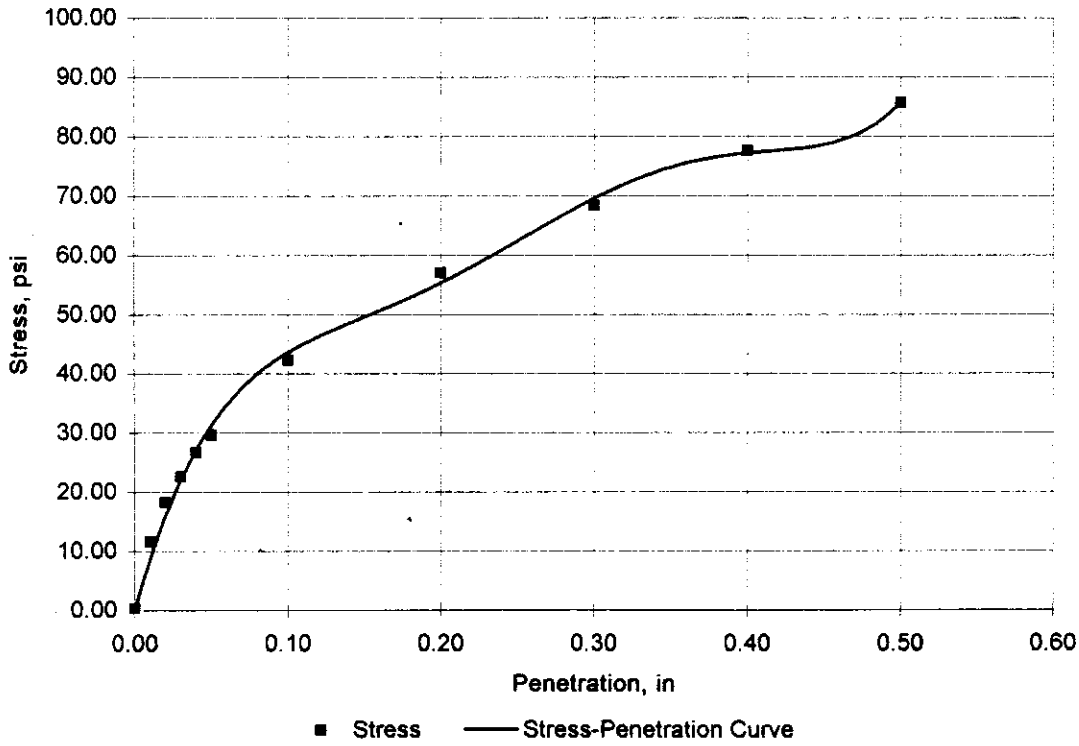
Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Soil and Test Method Data

Sample ID	AMU-8
Sample Depth	2'-4'
Test Method	ASTM D1883, compacted with mechanical hammer
Sample Preparation	Air dried, sieved through a 3/8" sieve and moisture conditioned.
Soak	>96 hours

Test Data

Compacted Moisture Content	13.4%
Compacted Dry Density	118.4
Percent Compaction	100%
Percent Swell	0.3%
CBR @ 0.1"	4.2
CBR @ 0.2"	3.8



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-9
Sample Depth 0'-2'

Natural Moisture Content

Pan ID	34	
Pan Wt	192.80	grams
Pan + Soil (wet)	378.33	grams
Pan + Soil (dry)	358.11	grams
Natural Moisture Content	*12.2%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	AMU-9
Sample Depth	2'-4'
Visual Sample Description	Gray Clayey SAND

Natural Moisture Content

Pan ID	X4	
Pan Wt	8.34	grams
Pan + Soil (wet)	142.66	grams
Pan + Soil (dry)	120.69	grams
Natural Moisture Content	*19.6%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	57.71	grams
Percent Passing No. 200 Sieve	56.1%	
Pan + Soil retained on No. 4 sieve (dry)	8.34	grams
Percent Passing No. 4 Sieve	100.0%	
Soil Classifies as	*Fine-Grained Soil*	

Atterberg Limits

Liquid Limit

No of Blows	16	20	34
Pan ID	94	101	108
Pan Wt	23.84	23.98	33.14
Pan + Soil (wet)	34.24	31.56	46.81
Pan + Soil (dry)	31.08	29.38	43.1
Moisture Content	44%	40%	37%
Liquid Limit	41	39	39
Liquid Limit	*40*		

Plastic Limit

Pan ID	26	30
Pan Weight	2.35	2.40
Pan + Soil (wet)	7.66	8.28
Pan + Soil (dry)	6.84	7.38
Moisture Content	18%	18%
Plastic Limit	*18*	
Plastic Index	*21*	

USCS Classification

Group Symbol	CL
Group Name	Sandy Lean CLAY

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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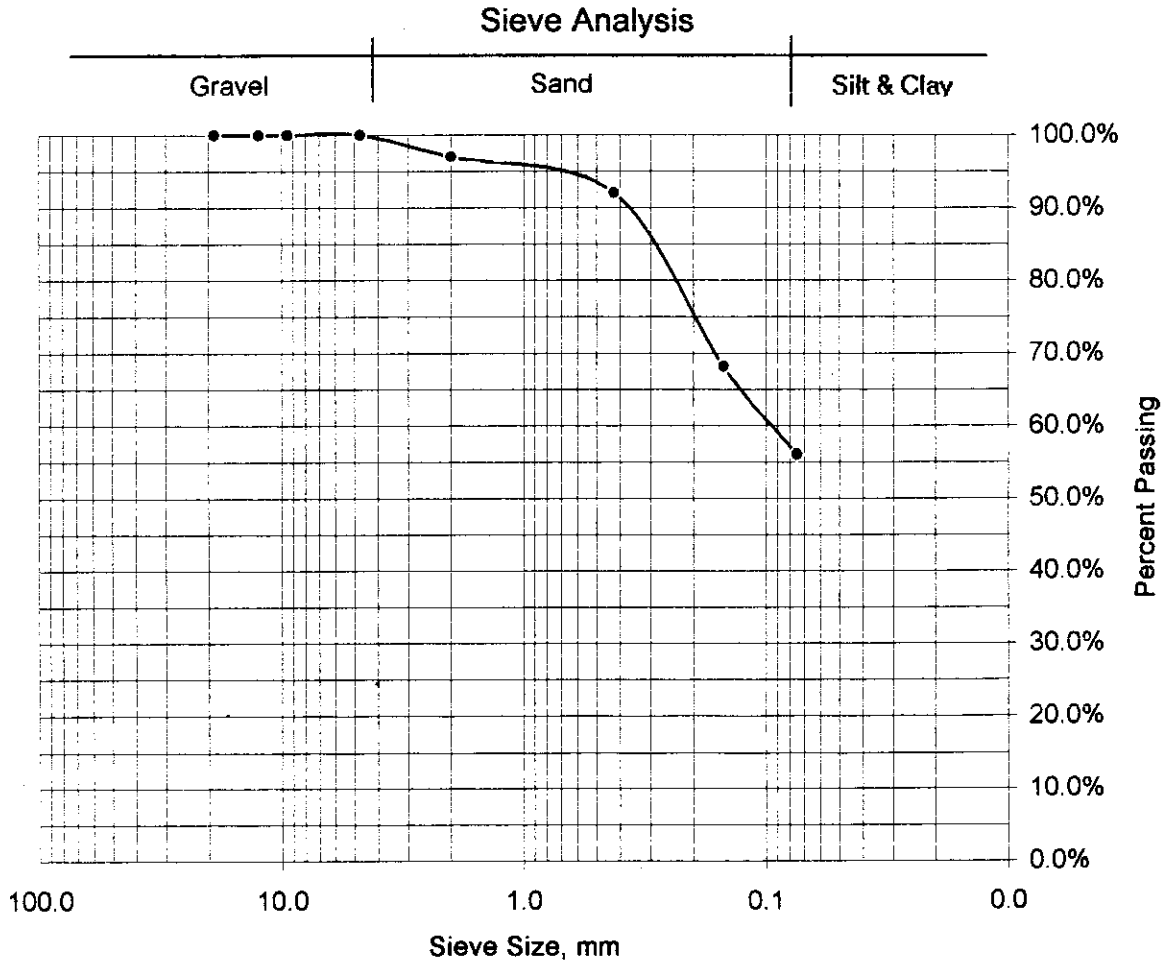
Sample ID AMU-9
Sample Depth 2'-4'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	3.39	3.0%	2.0	97.0%
No. 40	5.52	4.9%	0.425	92.1%
No. 100	26.84	23.9%	0.15	68.2%
No. 200	13.66	12.2%	0.075	56.0%
Pan	0.17	0.2%		
Total	49.58	44.0%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID AMU-9
Sample Depth 4'-6'

Natural Moisture Content

Pan ID	11
Pan Wt	187.89 grams
Pan + Soil (wet)	379.67 grams
Pan + Soil (dry)	351.82 grams
Natural Moisture Content	*17.0%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	AMU-9
Sample Depth	6'-8'
Visual Sample Description	Gray/brown Coarse SAND w/ trace of Clay

Natural Moisture Content

Pan ID	25	
Pan Wt	194.04	grams
Pan + Soil (wet)	321.90	grams
Pan + Soil (dry)	308.23	grams
Natural Moisture Content	*12.0%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	292.21	grams
Percent Passing No. 200 Sieve	14.0%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID AMU-9
Sample Depth 8'-10'

Natural Moisture Content

Pan ID	37
Pan Wt	194.22 grams
Pan + Soil (wet)	395.39 grams
Pan + Soil (dry)	343.67 grams
Natural Moisture Content	*34.6%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
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Sample ID	AMU-9
Sample Depth	13'-15'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	40	
Pan Wt	192.65	grams
Pan + Soil (wet)	277.60	grams
Pan + Soil (dry)	256.34	grams
Natural Moisture Content	*33.4%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	246.78	grams
Percent Passing No. 200 Sieve	15.0%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-9
Sample Depth 18-20'

Natural Moisture Content

Pan ID	37
Pan Wt	194.24 grams
Pan + Soil (wet)	335.74 grams
Pan + Soil (dry)	300.20 grams
Natural Moisture Content	*33.5%*

Soil Classification Calculations

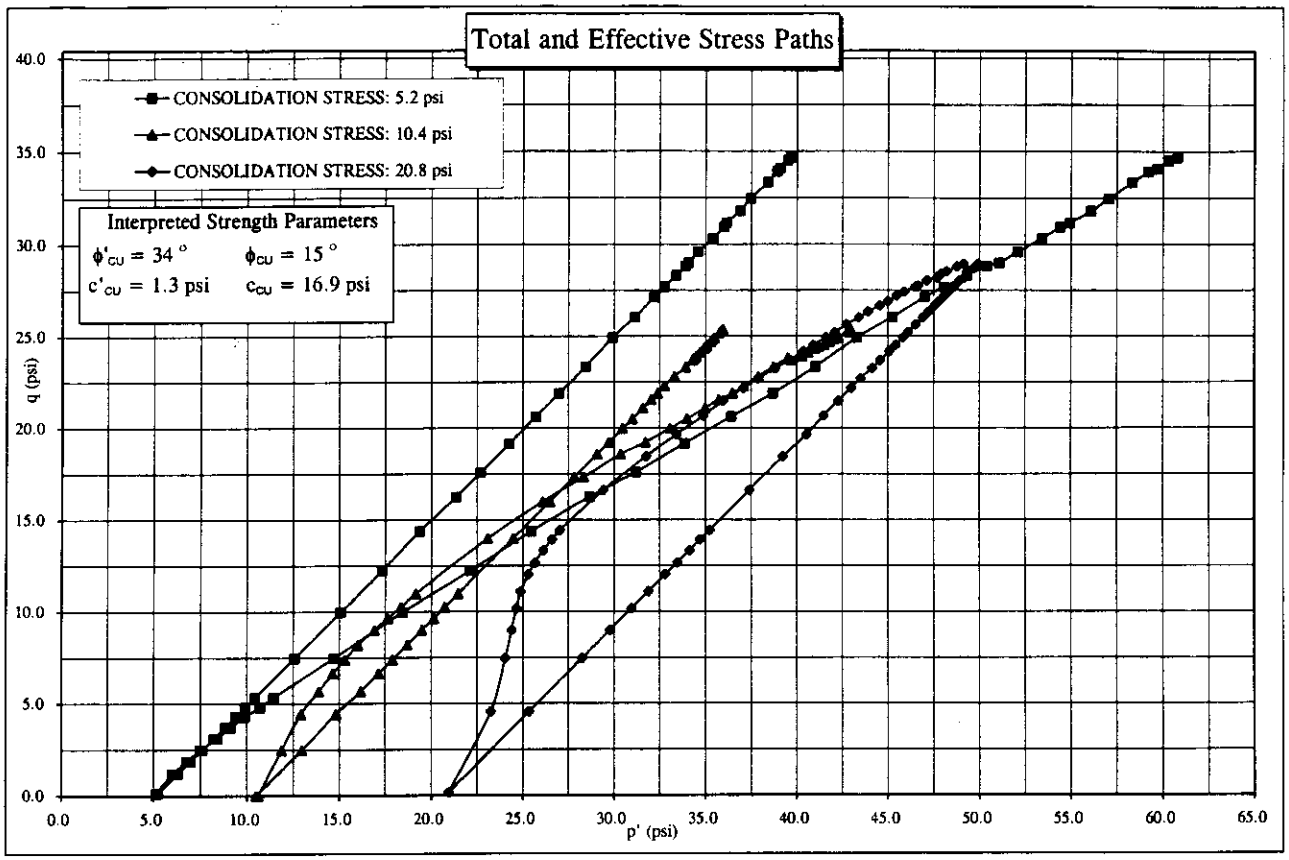
Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-9
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	24	
Pan Wt	186.25	grams
Pan + Soil (wet)	327.54	grams
Pan + Soil (dry)	292.25	grams
Natural Moisture Content	*33.3%*	



Sample No.: 7882
Exploration No.: AMU-9
Sample I.D. / Depth: 23-25 feet

	SAMPLE NO. 7882A	7882B	7882C
INITIAL			
Wet Weight, g	130.2	135.0	144.3
Dry Weight, g	97.9	100.0	106.9
Water Content, %	33.0	35.0	35.0
Wet Density, pcf	117.0	116.0	118.0
Dry Density, pcf	88.0	85.9	87.4
Saturation, %	97.4	98.4	100.0
Void Ratio	0.92	0.96	0.94
Diameter, in	1.362	1.370	1.383
Height, in	2.908	3.006	3.100
Saturation Method	Wet	Wet	Wet
B-Parameter	1.00	1.00	0.98
t_{50}, minutes	3.2	1.6	1.7
AT TEST			
Wet Weight, g	130.0	133.9	142.7
Dry Weight, g	97.9	100.0	106.9
Water Content, %	32.8	33.9	33.5
Wet Density, pcf	118.3	116.7	119.1
Dry Density, pcf	89.1	87.1	89.2
Saturation, %	99.4	98.1	100.0
Void Ratio	0.89	0.93	0.91
Area, in^2	1.445	1.461	1.481
Diameter, in	1.356	1.364	1.373
Height, in	2.896	2.992	3.084

GRADATION

Sieve Size	% Passing
3/8-in (9.5-mm)	-
No. 4 (4.75-mm)	-
No. 10 (2.0-mm)	-
No. 40 (0.425-mm)	-
No. 100 (0.150-mm)	-
No. 200 (0.075-mm)	-

Liquid Limit, %	-
Plastic Limit, %	-
Plasticity Index, %	-
Classification	-
Est. Specific Gravity	2.7

TEST SUMMARY

	7882A	7882B	7882C
Strain Rate, %/min	0.12	0.26	0.24
Cell Pressure, psi	45.2	50.4	60.8
Back Pressure, psi	40.0	40.0	40.0
σ_{3CON}, psi	5.2	10.4	20.8
Failure Criteria	15.0%	σ_{DMAX}	15.0%
σ_{DMAX}, psi*	69.2	50.7	57.7
Axial Strain at Failure, %	15.0	14.7	15.0
σ_{1F}, psi*	92.5	68.3	77.9
σ_{3F}, psi*	23.3	17.6	20.2

*Filter paper and membrane corrections have been applied.

REMARKS

Sample collection, handling methods, and other factors not disclosed to the laboratory testing firm could have affected the test results and the values reported. The test results are based upon interpretation of data collected through the test process. These interpretations do not consider the specifics of the project to which they will be applied. Therefore, all test results must be confirmed by a qualified geotechnical engineer for consistency with their intended use.

Virginia Geotechnical Services, P.C.
8211 Hermitage Road
Richmond, Virginia 23228
Telephone: (804) 266-2199
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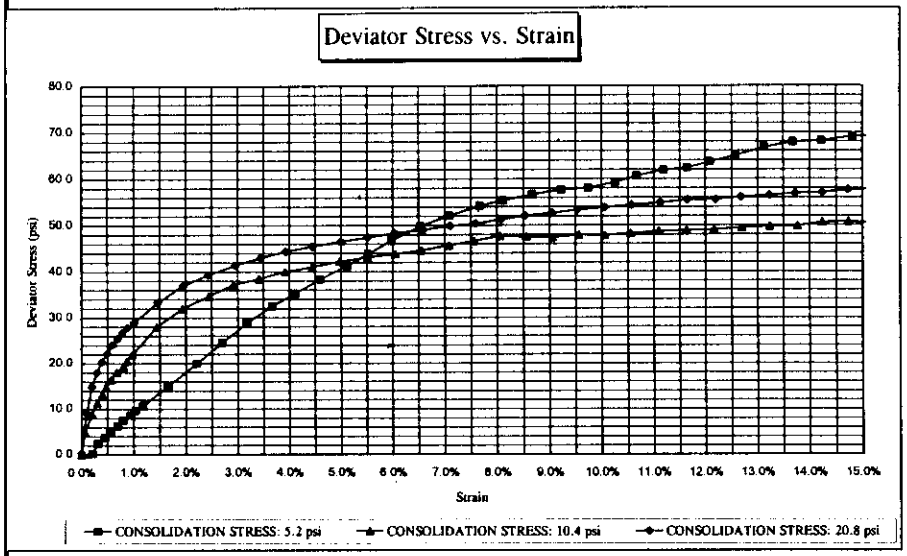
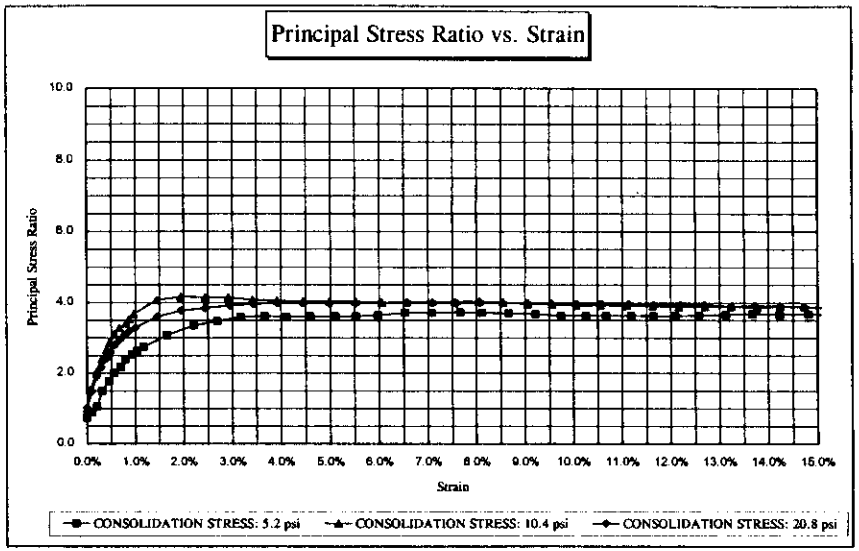
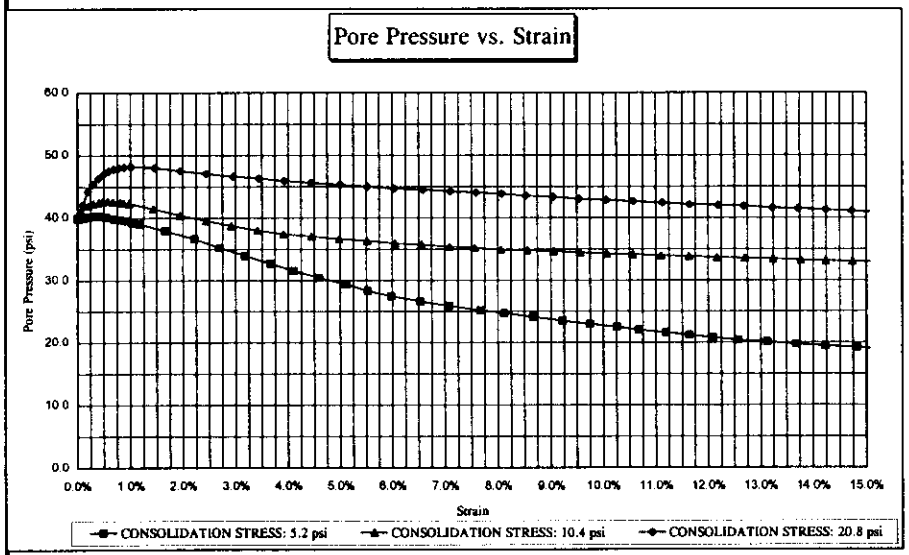
ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL TEST (ASTM D4767)

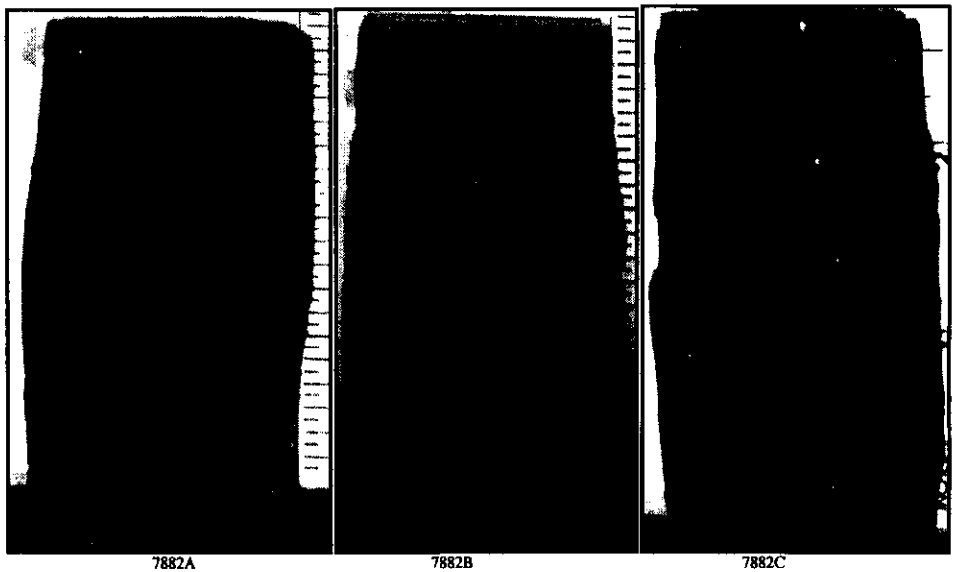
Project: Langley Air Force Base (F-22)
Client: EEE Consulting
Location: Hampton, VA
Project No.: GT1688

Sample No.: 7882
Exploration No.: AMU-9
Sample I.D. / Depth: 23-25 feet









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ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL TEST

Project: Langley Air Force Base (F-22)
Client: EEE, Consulting
Location: Hampton, VA
Project No.: GT1688

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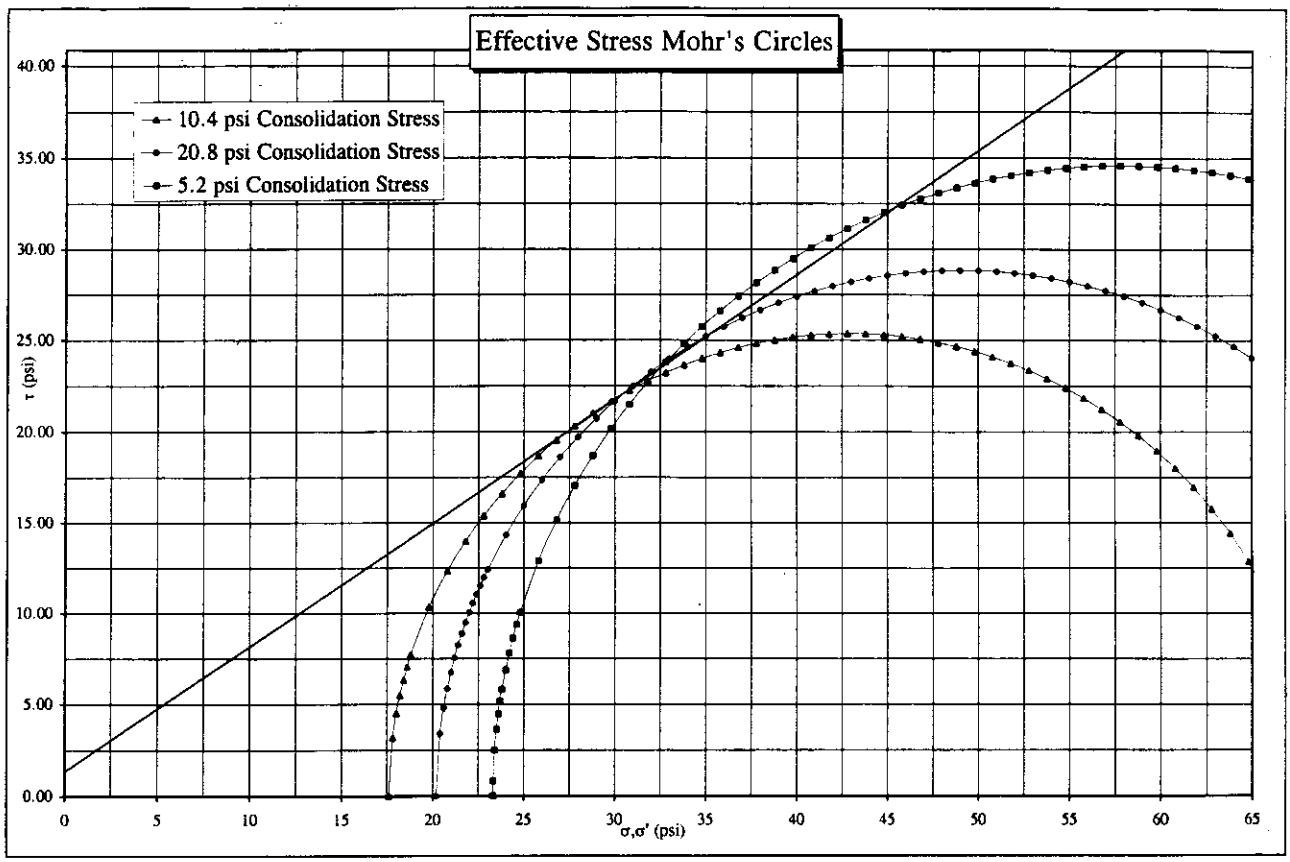

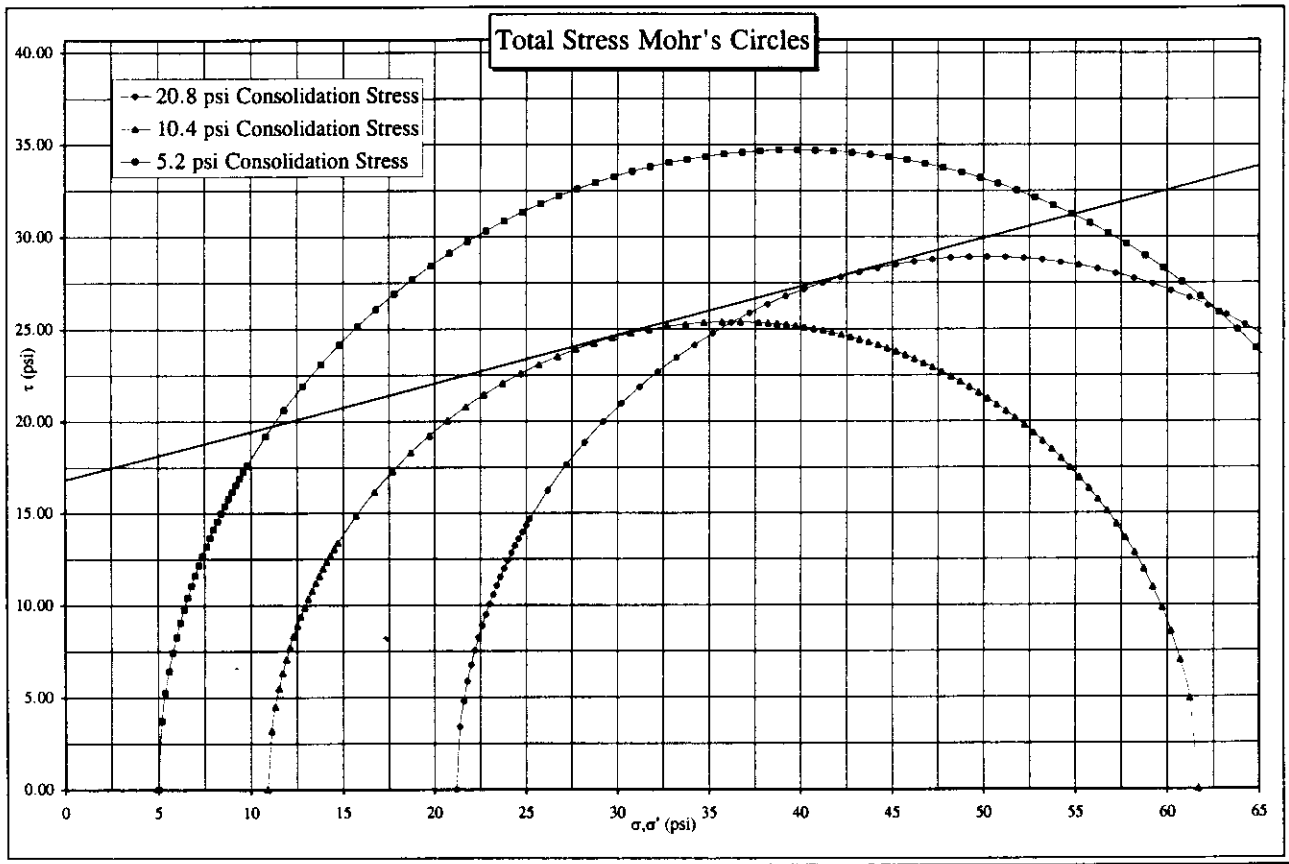

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ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL TEST (ASTM D4767)

Project:	Langley Air Force Base (F-22)
Client:	EEE Consulting
Location:	Hampton, VA
Project No.:	GT1688

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Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-9
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	12	
Pan Wt	184.93	grams
Pan + Soil (wet)	371.15	grams
Pan + Soil (dry)	324.03	grams
Natural Moisture Content	*33.9%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID AMU-9
Sample Depth 33'-35'

Natural Moisture Content

Pan ID	29	
Pan Wt	191.89	grams
Pan + Soil (wet)	384.46	grams
Pan + Soil (dry)	316.80	grams
Natural Moisture Content	*54.2%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 0'-2'

Natural Moisture Content

Pan ID	A112	
Pan Wt	8.28	grams
Pan + Soil (wet)	151.09	grams
Pan + Soil (dry)	138.02	grams
Natural Moisture Content	*10.1%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 2'-4'

Natural Moisture Content

Pan ID	A113	
Pan Wt	8.57	grams
Pan + Soil (wet)	124.75	grams
Pan + Soil (dry)	109.99	grams
Natural Moisture Content	*14.6%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 4'-6'

Natural Moisture Content

Pan ID	A111	
Pan Wt	8.15	grams
Pan + Soil (wet)	78.56	grams
Pan + Soil (dry)	66.81	grams
Natural Moisture Content	*20.0%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 6'-8'
Visual Sample Description Gray Silty SAND

Natural Moisture Content

Pan ID	A113	
Pan Wt	8.16	grams
Pan + Soil (wet)	110.70	grams
Pan + Soil (dry)	92.36	grams
Natural Moisture Content	*21.8%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	69.46	grams
Percent Passing No. 200 Sieve	27.2%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	PH-1
Sample Depth	8'-10'
Visual Sample Description	Brown/Gray Silty SAND

Natural Moisture Content

Pan ID	A112	
Pan Wt	8.16	grams
Pan + Soil (wet)	129.88	grams
Pan + Soil (dry)	101.10	grams
Natural Moisture Content	*31.0%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	80.93	grams
Percent Passing No. 200 Sieve	21.7%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 13'-15'

Natural Moisture Content

Pan ID	A109	
Pan Wt	8.24	grams
Pan + Soil (wet)	156.77	grams
Pan + Soil (dry)	117.88	grams
Natural Moisture Content	*35.5%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID PH-1
Sample Depth 18'-20'

Natural Moisture Content

Pan ID	A107	
Pan Wt	8.14	grams
Pan + Soil (wet)	129.47	grams
Pan + Soil (dry)	98.01	grams
Natural Moisture Content	*35.0%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID PH-1
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	A104	
Pan Wt	8.26	grams
Pan + Soil (wet)	149.66	grams
Pan + Soil (dry)	114.16	grams
Natural Moisture Content	*33.5%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID PH-1
Sample Depth 28'-30'

Natural Moisture Content

Pan ID	A101	
Pan Wt	8.19	grams
Pan + Soil (wet)	119.64	grams
Pan + Soil (dry)	92.00	grams
Natural Moisture Content	*33.0%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID PH-1
Sample Depth 33'-35'

Natural Moisture Content

Pan ID	A103	
Pan Wt	8.23	grams
Pan + Soil (wet)	150.73	grams
Pan + Soil (dry)	114.68	grams
Natural Moisture Content	*33.9%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 38'-40'

Natural Moisture Content

Pan ID	A108	
Pan Wt	8.18	grams
Pan + Soil (wet)	116.10	grams
Pan + Soil (dry)	86.61	grams
Natural Moisture Content	*37.6%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID PH-1
Sample Depth 43'-45'

Natural Moisture Content

Pan ID	A100	
Pan Wt	8.67	grams
Pan + Soil (wet)	167.92	grams
Pan + Soil (dry)	126.14	grams
Natural Moisture Content	*35.6%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID PH-1
Sample Depth 48'-50'

Natural Moisture Content

Pan ID	M-15	
Pan Wt	8.21	grams
Pan + Soil (wet)	132.90	grams
Pan + Soil (dry)	100.02	grams
Natural Moisture Content	*35.8%*	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID VT-1
Sample Depth 0'-2'

Natural Moisture Content

Pan ID	3
Pan Wt	193.14 grams
Pan + Soil (wet)	347.74 grams
Pan + Soil (dry)	333.38 grams
Natural Moisture Content	*10.2%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	VT-1
Sample Depth	2'-4'
Visual Sample Description	Brown Clayey SAND

Natural Moisture Content

Pan ID	22	
Pan Wt	189.01	grams
Pan + Soil (wet)	320.48	grams
Pan + Soil (dry)	301.56	grams
Natural Moisture Content	*16.8%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	260.47	grams
Percent Passing No. 200 Sieve	36.5%	
Pan + Soil retained on No. 4 sieve (dry)	191.71	grams
Percent Passing No. 4 Sieve	97.6%	
Soil Classifies as	*Coarse-Grained Soil*	

Grain Size Distribution Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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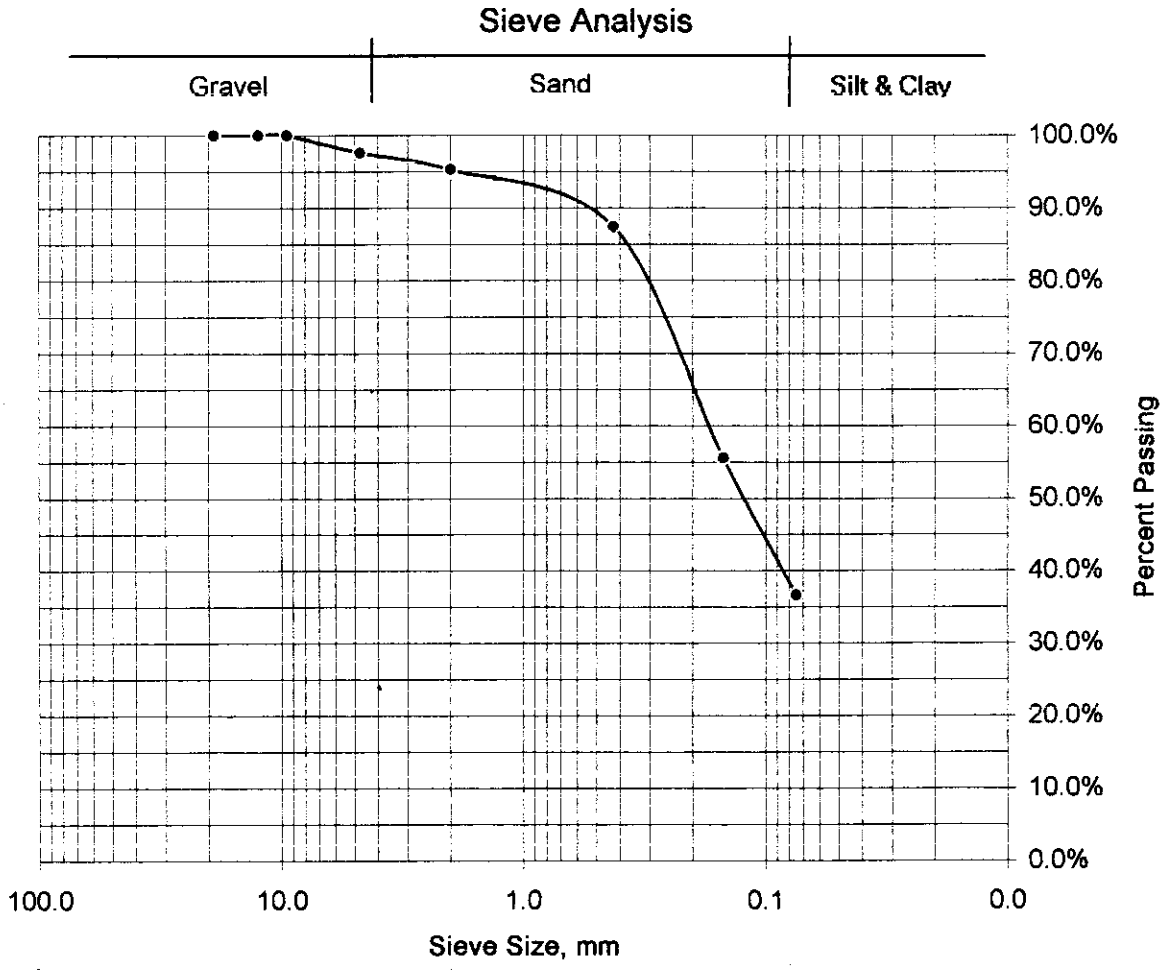
Sample ID VT-1
Sample Depth 2'-4'

Mechanical Sieve Analysis

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	2.70	2.4%	4.75	97.6%
No. 10	2.62	2.3%	2.0	95.3%
No. 40	8.85	7.9%	0.425	87.4%
No. 100	35.87	31.9%	0.15	55.5%
No. 200	21.28	18.9%	0.075	36.6%
Pan	0.21	0.2%		
Total	71.53	63.4%		



Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
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Sample ID VT-1
Sample Depth 4'-6'

Natural Moisture Content

Pan ID	34
Pan Wt	192.76 grams
Pan + Soil (wet)	320.48 grams
Pan + Soil (dry)	295.02 grams
Natural Moisture Content	24.9%

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID VT-1
Sample Depth 8'-10'

Natural Moisture Content

Pan ID	4
Pan Wt	195.06 grams
Pan + Soil (wet)	344.36 grams
Pan + Soil (dry)	309.06 grams
Natural Moisture Content	*31.0%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	VT-1
Sample Depth	13'-15'
Visual Sample Description	Gray Silty SAND

Natural Moisture Content

Pan ID	30	
Pan Wt	193.57	grams
Pan + Soil (wet)	354.39	grams
Pan + Soil (dry)	313.75	grams
Natural Moisture Content	*33.8%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	296.97	grams
Percent Passing No. 200 Sieve	14.0%	

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID VT-1
Sample Depth 18'-20'

Natural Moisture Content

Pan ID	29
Pan Wt	192.06 grams
Pan + Soil (wet)	337.38 grams
Pan + Soil (dry)	303.68 grams
Natural Moisture Content	*30.2%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associates
Blacksburg • Richmond, Virginia
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Sample ID VT-1
Sample Depth 23'-25'

Natural Moisture Content

Pan ID	11
Pan Wt	187.80 grams
Pan + Soil (wet)	313.62 grams
Pan + Soil (dry)	287.26 grams
Natural Moisture Content	*26.5%*

Soil Classification Calculations

Langley AFB, F-22 Bed-down Facility
DAA # R01121-01
Prepared By: LTW

Draper Aden Associate
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	VT-2
Sample Depth	2'-4'
Visual Sample Description	Brown Clayey SAND

Natural Moisture Content

Pan ID	36	
Pan Wt	193.81	grams
Pan + Soil (wet)	315.08	grams
Pan + Soil (dry)	296.50	grams
Natural Moisture Content	*18.1%*	

Coarse or Fine Grained

Pan + Soil retained on No. 200 sieve (dry)	250.50	grams
Percent Passing No. 200 Sieve	44.8%	